Improved Interim Procedures for Establishing Resource Damage Payments

Jack L. Knetsch
School of Resource and Environmental Management
Simon Fraser University
Burnaby, British Columbia

Thomas C. Brown
Rocky Mountain Research Station
Fort Collins, Colorado

The objectives of this agreement were to:

1. Investigate damage valuation issues and describe alternatives to direct valuation, including the use of schedules of damage payments.

2. Design and pilot test a vehicle for investigating the consistency of the rankings of values of alternative environmental damages.

3. Implement the vehicle and analyze the results of the implementation.

4. Document the results, and speculate on the form and utility of an operational environmental damage payment schedule, in a report suitable for submission to a scientific journal.

This final report consists of the following two papers:

1. Assessing non-pecuniary environmental losses: an interim damage schedule. 1995. Master's thesis by Murray B. Rutherford, School of Resource and Environmental Management, Simon Fraser University.

2. Assessing environmental losses: judgments of importance and damage schedules. 1997 manuscript by Murray B. Rutherford, Jack L. Knetsch, and Thomas C. Brown.

Note that a later version of the second paper appeared in the *Harvard Environmental Law Review* 22(1): 51-101, 1998.

ASSESSING NON-PECUNIARY ENVIRONMENTAL LOSSES:
AN INTERIM DAMAGE SCHEDULE

by

Murray Bruce Rutherford

B.Sc., University of British Columbia, 1976

LL.B., University of British Columbia, 1979

RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF RESOURCE MANAGEMENT

in the

School of Resource and Environmental Management

Report No. 171

© Murray B. Rutherford 1995

SIMON FRASER UNIVERSITY

November 1995

Table of Contents

List of Tables

List of Figures

Assessing Non-Pecuniary Environmental Losses:
An Interim Damage Schedule

Introduction

For at least three decades, economists and policy makers have sought ways to measure the economic values of non-pecuniary environmental assets (environmental assets that do not have observable market prices). Although tremendous effort has been devoted to the search,[1] a fully satisfactory technique for measuring these values has not emerged. The valuation methods currently used are expensive, limited in scope, or, in many cases, simply inaccurate.[2]

Decisions affecting the natural environment are, therefore, frequently made without adequate information about values. Policy makers must not only attempt to predict and assess the probabilities of possible outcomes (or effects) of contemplated actions, they must also estimate how people value those outcomes, how they value the environmental assets affected thereby, and how they feel about the risks involved. Non-pecuniary environmental assets may easily be under-weighted or over-weighted in decisions, leading to controversy and inefficiency, and requiring costly sorting-out. Accurate measures of values, combined with better information about social perceptions of uncertainty and risk, could guide decisions toward more efficient and appropriate

---

[1] For example, Vatn and Bromley (1994, p. 129) report that during the period from 1990 through 1993, approximately one-third of the articles in two prominent journals of resource economics (*Land Economics* and the *Journal of Environmental Economics and Management*) were devoted to valuation.

[2] See the discussion in Section II.

1

resource allocations; more precise and acceptable assessments of damages for environmental harm; and other desirable policy outcomes.

The limitations of existing valuation methods have been particularly apparent in assessments of environmental losses. Statutes such as the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) (United States (b)) and the Oil Pollution Act of 1990 (OPA) (United States (c)), stipulate that those who cause environmental harms must pay compensation. When a publicly owned asset is damaged, the appropriate amount to charge is the aggregate social value of the loss. But when that value cannot be determined, damage assessments are unlikely to efficiently achieve the deterrence and restitution objectives for which they are intended.

The disappointing performance of post-incident economic valuation methods has led some policy makers to consider alternative ways of assessing environmental losses.[3] For example, in Washington State damages arising from small spills of oil or other hazardous substances are assessed under an administratively prescribed damage schedule, in which compensation amounts are arbitrarily specified in advance, varying with the size of spill, the type of substance spilled, and the geographic location of the damage (Washington State). Similar schedules have been adopted in other jurisdictions in the United States for assessing damages caused by small spills.[4] Proponents claim that these "environmental damage schedules" produce simplified, inexpensive and certain

---

[3] The cost and perceived inadequacy of ad hoc value assessment have been the main incentives for change (see Geselbracht and Logan). The 1985 Arco Anchorage crude oil spill in Washington State is a striking example--the environmental assessment cost $245,000, but damages were assessed at only $32,930 (Grigalunas and Opaluch 1988, p.512). Moreover, it cannot be asserted with confidence that the values were accurately assessed, or that the damages charged provide any real guidance to the actions of others.

[4] See the discussion in Section III.

2

calculations of compensation amounts, making damage assessments more efficient and more enforceable (Plante et al. 1993; Geselbracht and Logan).

According to Plante et al. (1993, p.718) Florida's environmental damage schedule borrows "the concept of liquidated damages from contract law to develop a formula by which a monetary equivalent of the damage to the natural resources [can] be calculated."[5] This analogy is particularly apt, as in both cases the need for an agreed assessment arises because it will be difficult or expensive to determine the actual value of losses. Like contracts, damage schedules are (to a large extent) the product of negotiations between interested parties. Environmental policy makers, industry, non-governmental organizations and others can provide predictability and enforceability by specifying in advance the damage payments that will be required in the event of a loss. It is, perhaps, more rational to undertake this "settlement" of damages once (or once every few years as circumstances change), on a general basis and in forums designed for establishing public policy, rather than conducting the process repeatedly, after damage takes place, in costly forums that are not well suited for public input or negotiation.[6]

---

[5] Liquidated damages clauses are used in contracts when the parties foresee that it will be difficult or expensive to assess the value of losses in the event that an agreement is breached. In the interest of expediency and predictability, they assign in advance a dollar amount to the consequences of a breach. A contractual specification of liquidated damages is normally enforceable if it can reasonably be considered to be a genuine pre-estimate of the anticipated value of the loss, rather than a penalty for breach of the contract (Waddams 1991, pp. 8-14 to 8-19).

[6] There is another sense in which legislated damage schedules involve "agreement" between the parties. Potential polluters can make themselves aware of specified damage amounts before undertaking activities that may pollute, and can decide not to proceed, or to modify procedures accordingly. "Inherent in the relationship between the state, as trustees over the natural resource through and over which commercial shipping occurs, and shipowners and vessel masters is an implied contract. In return for the consideration of the ability to ply the state's waters, shipowners agree to conduct their activities in such a manner as to minimize the impact on the environment, and, in the event that such activities damage the state's natural resources, to offer reasonable compensation" (Plante et al. 1993, at p.718).

This paper explores the potential of environmental damage schedules as substitutes for post-incident measures of non-pecuniary environmental losses. A broader issue is also considered: whether the values of non-pecuniary environmental assets and losses might be better assessed on the basis of relative importance, rather than in terms of the monetary estimates produced by the economic measurement methods which are now available. I suggest that the problems encountered by economists in attempting to measure the values of non-pecuniary environmental assets may be more fundamental than is commonly accepted; that these problems may arise from important characteristics of human values that are overlooked by economic valuation techniques.

It is possible that valuations vary in different contexts; that there exist distinct dimensions of value; and that the values of different entities cannot always be reduced to a single metric (such as dollars) for comparison.[7] If so, then attempts to assess non-pecuniary values by existing economic techniques, such as asking people how much they would be willing to pay to preserve an asset, are unlikely to capture true social values. More reliable value information might be elicited by instead asking people to compare the relative importance of environmental assets (or losses) of similar type, in similar contexts, without asking that they express their values in monetary terms, across contexts and across types of assets.

For example, the non-pecuniary loss suffered as a result of cutting one hectare of old growth coastal temperate rain forest might be considered by some to be more important than the non-pecuniary loss arising from cutting one hectare of second growth forest in a similar setting. The loss of the last known nesting site of an endangered species of bird might be considered by some to be more significant than the loss of a single

---

[7] These possibilities are discussed in Section II.

4

robin's nest. I explain how such preferences among assets or losses can be elicited from individuals, aggregated and scaled at an interval level, and combined into a matrix showing the relative importance of a variety of non-pecuniary environmental assets or losses (for convenience, I call this type of matrix a "ranking matrix"). The ranking matrix can then be used to structure the remedies prescribed in an "interim" damage schedule.[8]

A brief description of the proposed ranking matrix and interim damage schedule will help with the discussion which follows.[9] Psychologists have developed a variety of techniques for determining the preferences of individuals, and for scaling and aggregating those preferences.[10] These psychometric techniques can be used to derive, from individual choices, scaled rankings of the relative importance of different environmental harms. By sampling representative portions of the public, individual choices can be aggregated to express social rankings. The social rankings can then be arrayed in a ranking matrix, in which the matrix axes represent variables found empirically to have significant effects on people's choices of comparative importance. For instance, some axes of the matrix might include qualitative and quantitative descriptions of physical and biological characteristics of different environmental losses, or "consequences," that affect rankings (such as the death of fifty marine birds of a particular species, or the loss of one hundred marine mammals of a particular species). Other axes might describe important

---

[8] The term "interim" is used because it is intended that the schedule will be adjusted with developing valuation information and changing circumstances.

[9] The concepts are explained in more detail in Sections IV and V.

[10] One such technique, "Thurstone's Paired Comparison Method," was used in the empirical study discussed in Section IV.

characteristics of the environmental "occurrences" that cause losses (such as an oil spill, or a landslide caused by logging road construction).

By incorporating a variety of different descriptive and contextual variables, a ranking matrix would allow more of the characteristics that influence human decisions about relative importance to be expressed. The rankings in each cell of the matrix would represent the scaled relative importance of a particular combination of occurrence characteristics and consequence characteristics. Although at first the matrix might consist of only a few selected "typical" environmental assets or losses, as other losses of differing form or magnitude were encountered, involving the same or different assets, their relative importance could be derived by interpolating or extrapolating from those previously ranked--so that an increasingly comprehensive profile of relative importance gradually evolves. An environmental damage schedule could then be constructed from the ranking matrix, by assigning to each environmental harm a dollar amount or other remedy appropriate to its importance in comparison with other harms.

In addition to serving as the basis for an interim damage schedule, a ranking matrix of scaled relative importance might have wider policy applications. Similar matrices have been used in risk studies to express characteristics, such as voluntariness and controllability, that influence public perceptions about the relative significance of different risks.[11] A ranking matrix could be designed to evaluate the relative social importance of alternative decision outcomes, by describing those outcomes in terms of the assets potentially affected and the types and probabilities of harm. The cells in such a matrix would not only express the relative social importance of the assets involved, but also the relative social significance of the risks to those assets. This information could

---

[11] See, for example, Slovic (1987).

assist policy makers in choosing between alternative courses of action, or determining when to regulate or prohibit harmful activities.

The discussion herein proceeds as follows. Section I reviews the roles that accurately assessed values are generally thought to play in policy and decision making (later, these roles are used as criteria to evaluate the ranking matrix and interim damage schedule concepts). Section II considers several major issues that have hampered attempts to measure non-pecuniary environmental values. Section III examines some existing or proposed schedules of compensation for non-pecuniary losses, to show how these initiatives have been applied in practice. Section IV reports the results of a preliminary empirical study testing the ability of individuals to make consistent choices between non-pecuniary environmental losses, and demonstrates a simple method of aggregating and interval-scaling their preference responses. Section V explains how a ranking matrix and interim damage schedule can be constructed from preference data. Section V concludes with an evaluation of how well the resulting matrix and schedule could serve the purposes for which accurately assessed values are generally thought to be useful.

An interim damage schedule of the type proposed here would necessarily be arbitrary, both in the original derivation of the figures and in the generality of application of those figures. However, I conclude that some degree of arbitrariness may well be outweighed by greater certainty, better enforceability and reduced transaction costs. In addition, given the indeterminacy of the methods currently used to assess non-pecuniary environmental values, a damage schedule based on rankings of relative importance might in practice be no more arbitrary than ad hoc measurement; might well be more equitable; and might better express actual social values, as well as being less costly.

I. Environmental Values in Public and Private Decision Making

According to standard economic theory, the relative values held by society for "pecuniary" environmental assets (those that are bought and sold in markets) are expressed in forces of supply and demand, which in turn determine prices. The price of a good assesses the marginal value to consumers of obtaining an additional unit of that good, which, in perfectly competitive markets at equilibrium, is equal to the marginal cost to producers of supplying an additional unit of the same good. In theory, then, prices convey value information and supply the correct incentives to ensure efficient allocations of resources among different uses and users in society. Price information is also utilized in the public sector, to assess damages to public assets, conduct benefit-cost analysis, allocate resources among citizens and uses, and make other policy decisions.

Non-pecuniary environmental assets are no less economically valuable than pecuniary assets, but their values cannot be ascertained from market prices. Measured values, when accurate, can be used as substitutes for market prices, again giving policy-makers the information needed to allocate resources appropriately, assign the socially correct "prices" to non-market assets, and assess damages. These roles of accurately measured values for non-pecuniary assets will be examined here in more detail, as they will be used in Section V as criteria to evaluate the usefulness of the ranking matrix and interim damage schedule concepts.

1. Allocation decisions

Accurately measured values give public policy makers the information needed to properly weight non-pecuniary assets in resource allocation decisions. For example, if the non-market values of wilderness areas are known, policies can be designed to protect the socially optimum amount of wilderness, without overly restricting other uses. When

8

values cannot be assessed accurately, policy makers are left to estimate public demand for wilderness areas, and are susceptible to the pressures of interest groups (whether in support of, or against, development). As a result, the social value of positions favored by dominant interest groups may be overestimated.

Full analysis of the benefits and costs of public choices requires accurate value information, but choices made after full benefit/cost analysis are less controversial and are more likely to improve aggregate social welfare than choices made without that information. Accurately determined values also help policy makers to more appropriately design and target environmental management, environmental restoration, and mitigation for public actions that harm environmental assets.

2. Getting the prices right

When non-priced resources are treated as having no value, they are wasted by over use. Assigning a "price," by requiring compensation for use, or by imposing regulatory restrictions, leads to more socially desirable levels of use. If the assigned price properly reflects social values, then the correct incentive and disincentive signals are given to producers and consumers. Resource prices are costs to primary users, and these costs motivate them to rationalize their use of alternative resources accordingly. Primary users pass the costs on to consumers, who adjust their consumption among available goods. For example, energy and water prices based on true values give incentives to consumers to conserve or shift consumption among different sources of supply, and to producers to make available the socially desirable amount of the resource and its alternatives, so that consumption and production levels are more socially optimum.

Accurate value-based prices also reduce the uncertainty of determining permissible use levels, and cut transaction costs, as consumers and producers adjust automatically to the announced prices. This allows more efficient planning of public and

9

private sector activities. As the costs of environmental losses become more predictable, liability insurance becomes more readily available at lower rates.[12]

3. Assessing damages

The practice of requiring damage payments from those who harm the environment can be justified in various ways. These will be reviewed here in some detail, as it is necessary to understand the justifications for requiring damage payments in order to properly evaluate the effectiveness of an interim damage schedule as a mechanism for assessing damages.

Economists generally emphasize the deterrence and compensation roles of damages. For example, Castle et al. (1994) identify three possible reasons for compensating public trustees in the United States for environmental harm:[13] i) to permit individual losers to be compensated; ii) to pay for environmental restoration; and iii) to deter future accidents. Each of these justifications can be attributed to an underlying desire to internalize externalities: to ensure that all of the costs of an action are borne by the party (the "actor") responsible for bringing those costs about. The standard analysis is that if the costs are properly measured in terms of full social value and are charged to the actor, environmental losses will be reduced to optimum levels. The amount that the actor

---

[12] The present scarcity of environmental insurance can be attributed in part to the uncertainty of environmental damage awards--it is almost impossible to predict the magnitude of potential losses. To some extent, this may be due to uncertainty about the probability and magnitude of harm, rather than uncertainty about the amount of damages that will be awarded. But as many potentially harmful activities have long experience records, actuaries may often be able to make reasonable predictions of the probabilities of losses of various magnitudes occurring. The less predictable process of assigning dollar values to the losses may be more problematic. This issue has perhaps not been given adequate consideration in environmental policy making, when compared with the emphasis given to expanding liability. Expanded liability is of little use if judgments are not recoverable.

[13] Under the Clean Water Act (United States (a)), CERCLA (United States (b)) and OPA (United States (c)), trustees are appointed to assess and collect environmental damages on behalf of the public.

will expend to avoid or minimize environmental damage will equal the value that society places on avoiding environmental loss.[14]

Radin (1993) (dealing with compensation for personal injuries) has a broader conception of the justifications for requiring damage payments for non-pecuniary harms. She emphasizes "corrective justice," which, in her view, roughly means:

> . . . to make required changes in an unjustified state of affairs between an injurer and a victim, when the injurer's activity has caused the injustice, so that such changes bring about a just state of affairs between them, and one that is related in a morally appropriate way to the status quo ante. A shorthand way of saying this is that corrective justice restores moral balance between the parties.

(Radin 1993, p. 60)

Moral balance may be achieved by restoring the parties to their original circumstances prior to the incident (restitution), or by restoring the parties to a situation that is morally equivalent to those circumstances (rectification--which can include restitution). Radin contrasts the "commodified" economic models of pure deterrence (in which corrective justice does not matter as long as the appropriate deterrence incentive is given) and deterrence/compensation (in which rectification can be achieved by substituting money for the loss suffered), with a "non-commodified" model of compensation, in which:

> Requiring payment is a way to bring the wrongdoer to recognize that she has done wrong and to make redress to the victim. Redress is not restitution or rectification. Redress instead means showing the victim that her rights are taken seriously. It is accomplished by affirming that some action is required to symbolize public respect for the existence of certain rights and public recognition of the transgressor's fault in disrespecting those rights.

(Radin 1993, p.61)

---

[14] Castle et al. (1994) go on to question whether accurately measured environmental values are needed to achieve the deterrence functions commonly attributed to environmental damages, and whether damages really act as deterrents in this context in any event.

Viewing compensatory damages as redress emphasizes fairness in dealing with losses, and takes into account the influences that laws have on perceptions of behavioral norms (Radin 1993).[15]

Another commonly suggested reason for paying compensation to those who suffer non-pecuniary harms, is to provide solace. Solace emphasizes the injured party rather than the injurer, and does not necessarily entail a judgment of wrongdoing. Interestingly, the Supreme Court of Canada has used the concept of solace to justify an overall cap on damages for pain and suffering in personal injury cases.[16] In considering the argument that the objective of compensation for non-pecuniary losses in such cases is to provide reasonable solace for the injured person's misfortune, Dickson, J. said:

> To my mind, this last approach has much to commend it, as it provides a rationale as to why money is considered compensation for non-pecuniary losses such as loss of amenities, pain and suffering, and loss of expectation of life. Money is awarded because it will serve a useful function in making up for what has been lost in the only way possible, accepting that what has been lost is incapable of being replaced in any direct way.

> (Andrews v. Grand & Toy, p. 262 S.C.R. and p. 476 D.L.R.)

Cane (1987, p. 474) also emphasizes the impossibility of replacing what has been lost:

> Since it is almost impossible in any modern legal system to award compensation in any form other than money, it follows that giving compensation for 'losses' which cannot be replaced by money (such as pain and suffering or loss of amenity) must have a different purpose from

---

[15] Kennedy (1976, p. 1694), in discussing compensatory damages in contract and tort, makes a similar distinction between conceptions of compensation that are indifferent to perceived "fault," and those that carry an element of moral judgment against the perpetrator of harm.

[16] The cap was initially set at $100,000, and is adjusted with inflation (Arnold v. Teno [1978] 2 S.C.R. 287, 83 D.L.R. (3d) 609; Andrews v. Grand & Toy [1978] 2 S.C.R. 229, 83 D.L.R. (3d) 452; Thornton v. Prince George School Board [1978] 2 S.C.R. 267, 83 D.L.R. (3d) 480).

that involved in giving compensation for things that can be replaced by money. The object here cannot be to replace what has been lost by some equivalent, but to enable the victim to obtain a substitute source of satisfaction or pleasure, or alternatively to comfort him (provide him with solace) for what has happened.

II. Measuring Values for Non-Pecuniary Environmental Assets

It is clear from the preceding discussion that accurately measured values can play important roles in public and private decision making. If the values of all environmental assets could be assessed accurately, decisions might be simpler, more efficient and more socially appropriate. Unfortunately, assessing values has proven to be difficult. This section reviews some of the major issues that have complicated attempts to measure the values of environmental assets. Some of the problems discussed here may eventually be resolved with improved measurement techniques, but others may be more intractable-- thus the need for alternative methods of damage assessment.

1. Imperfect markets and non-market assets

Market prices do not always correctly express underlying values for environmental assets. The market price of an asset relates only to the attributes of the asset that can be bought and sold, and as such does not reflect the value of non-market attributes. For example, prices generally do not include components of value such as existence value and other passive-use value.[17]

Moreover, market prices for environmental assets are often distorted by market failures, such as non-competitive markets and imperfect information. Common access

---

[17] Economists commonly separate the values held by humans for environmental assets into "use" value and "non-use," or "passive-use" value. Although exact classifications vary, it is generally agreed that the main component of use value is the value arising from direct use of an environmental asset. This includes consumptive activities, such as fishing and hunting, as well as activities normally considered to be non-consumptive, such as bird-watching. Some economists also classify "option" value (the value attributable to preserving the option of having an environmental asset available for use in the future) as a use value. Others classify option value as a passive-use or non-use value, because it does not involve current use by the valuing individual. Passive-use or non-use value generally includes all value that does not involve direct use of an environmental asset, including value attributable to the mere knowledge of the existence of the asset ("existence value"). Passive or non-use value poses the most difficulty for quantitatively assessing damages to the environment. (Based on Pearce and Turner 1990; and United States 1994b.)

14

problems[18] and other negative and positive externalities are prevalent, due to the historical abundance and physical characteristics of many environmental assets (for example, often environmental assets cannot be readily be defined as separate, divisible entities, making it impossible to allocate property rights such as the right to exclusive use). In addition, environmental assets frequently provide services with public good characteristics, in that once they are available for one person they are available for all, and, therefore, any single individual has little or no incentive to pay to assure their provision. All of these factors can cause market prices to differ from social values.

2. The appropriate measure of value: willingness to pay or willingness to accept?

Another important issue that arises in environmental value assessment is the choice of the correct measure to use: the amount that an individual is willing to pay to obtain (or preserve) an asset ("WTP"), or the amount that an individual is willing to accept in return for selling (or allowing the destruction of) the asset ("WTA"). Economic theory holds that, in the absence of income effects (and in most environmental valuations income effects are assumed to be inconsequential), WTP will be equivalent to WTA (see, for example, Randall 1987, p. 244; Rhoads 1985, p. 125). But many empirical investigations have found that people attribute substantially more value to losses, measured by WTA, than they attribute to identical gains, measured by WTP (see Knetsch and Sinden 1984; Boyce et al. 1992; and reviews of similar studies in Cummings et al. 1986; Kahneman et al. 1990; Knetsch 1994a; and Knetsch 1994b). Comparative studies report WTA/WTP

---

[18] The dominant economic theory of common access notes that when property is commonly owned and unpriced, in the sense that there is no charge for use, each individual user does not bear the full negative impact of his or her increasing use. Rational individual decisions will then lead to overuse, because the cost to each individual associated with increased use is less than the total social cost (Hardin 1968).

ratios ranging from approximately two to one, to five to one, and, in some circumstances, even higher (Kahneman et al. 1990).

One plausible explanation for the difference between WTA and WTP is that individuals assess changes from a given state of affairs by comparing the new state of affairs to their psychological reference points (Kahneman and Tversky 1979; Kahneman et al. 1991). The reference point for a particular decision may or may not correspond with the initial legal entitlement, or the state of affairs from which matters start; what is important is the state that is thought of as normal (or, in some cases, expected). Changes that are perceived from the reference point to lie within the domain of "gains" (actual gains, and negative changes that are characterized as foregone gains) are attributed less value than otherwise identical changes that are perceived from the reference point to lie within the domain of "losses" (actual losses, and positive changes that are perceived as reductions of losses) (Knetsch 1995).

If the goal of value assessment is to capture true social preferences, than these differences in perception should be taken into account. When the environment is damaged, the appropriate reference point is often the undamaged state of affairs, and the valuation method used to assess the loss should, therefore, measure WTA. Yet, in spite of wide recognition of the appropriateness of using the WTA measure to assess the value of losses, in practice nearly all economic valuation exercises attempt to estimate WTP measures (see, for example, United States 1994b).

3. Limited or poor measurement techniques

Most of the models developed by economists to measure values of non-pecuniary environmental assets determine those values indirectly, by examining market outcomes associated in some way with an asset or its substitutes. The common indirect valuation

methods are summarized below (based on Pearce and Turner 1990, pp. 141-158; and United States 1994b, pp. 1141-1142):

Restoration cost	measures the cost of restoring a damaged environmental asset to its original undamaged state.
Replacement cost	measures the value of an environmental asset by calculating the amount that would be required to purchase a substitute to provide the same flow of goods and services as the asset being valued
Travel cost	calculates an aggregate minimum value for a recreational area by measuring the expense, in terms of time and money, that individuals incur in order to visit the area.
Hedonic price	analyzes the bundle of attributes comprising a market good (such as a residential lot), and separates out the portion of the price of that good that is attributable to environmental amenities (such as a view, or proximity to a natural area).

Although these indirect measurement methods elicit economic values, each can only be used in limited circumstances. Restoration cost, for example, may be appropriate for assessing the value of environmental damage when it is possible to restore a damaged asset, but often this is not possible, due to bio-physical limitations or insufficient knowledge. Restoration cost also does not measure the value lost during the time when restoration is being effected, nor does it take account of any remaining loss if the restoration is deemed to be less than a perfect substitute for the original.[19]

---

[19] Courts in the United States have identified the diminution of value pending recovery of an environmental asset as an important component of damage assessment, and as a component that is missing from measures of replacement or restoration cost (Colorado v. U.S. Department of the Interior). Theoretically, the value lost during the recovery period could be compensated by charging interest on the full final cost from the time of the loss until restoration or replacement is effected. However, determining the rate of interest that will exactly compensate for the loss may be as problematic as directly assessing the value lost during the recovery period.

Replacement cost is an intuitively appealing valuation measure because it mimics market outcomes--replacement cost uses the market price of a substitute. But many environmental assets do not have marketed substitutes (for example, many species of fish and wildlife are not exchanged in markets [Halter and Thomas 1982]). Even when an apparent substitute with a market price can be found, it may be difficult to truly replace an element of the natural world. Hatchery programs designed to rebuild salmon stocks on the west coast of Canada and in the Pacific Northwest of the United States provide an illustration. Although hatchery-bred fish were originally used as replacements for lost natural stocks, and would, therefore, appear to provide a logical measure of the replacement value of damaged natural stocks, the hatchery fish have been found to lack the genetic diversity, disease resistance and general resilience of wild fish (see Wilkinson 1992, pp. 217-218).[20] Also, as with restoration cost, replacement cost measures do not capture the value lost during the replacement period.

The other indirect valuation methods have major shortcomings as well. The travel cost method is suitable only for a limited group of environmental assets, and for those assets measures only use value from the WTP perspective (Pearce and Turner 1990). Hedonic pricing techniques are even more limited in scope, and are hampered by the complexity of attempting to distinguish the influence of an environmental attribute from

---

[20] In addition, as gains seem to be valued differently than losses, "people's willingness to accept one resource gain as a substitute for the loss of another resource, may be more constrained than is usually presumed" (Knetsch 1994b, p. 355). With respect to damage assessment, this implies that rectification (restoring the parties to a situation that is morally equivalent to their circumstances prior to the incident) may be possible only through full restoration of the damaged asset, or true replacement with an identical asset (in the rare cases where this is possible)--in other words, through restitution (restoring the parties to their original circumstances prior to the incident). If the funds paid as damages are not actually used to repair or replace the asset, restitution will not be achieved.

the influences of the many other variables that can affect prices (Knetsch 1964. Pearce and Turner 1990).

Many environmental assets, then, are left un-priced in the market and un-priceable by the indirect valuation methods discussed above. Only one method--the contingent valuation method (CV)--has been widely used for assessing the values of non-pecuniary environmental assets directly (in other words, without relying on associated market prices). The basic premise is simple; if you want to find out how much people value aspects of the environment, ask them. CV surveys ask respondents how much they would be willing to pay for a given environmental asset, or how much they would be willing to pay to preserve that asset from destruction. Because CV is the only way of even attempting to estimate total values for most non-pecuniary environmental assets, the method has been extensively studied and refined.[21] However, empirical evidence suggests that the responses to CV questions do not really measure the amounts that, or the ways in which, people value the environment. As CV is the prevailing method for assessing non-pecuniary environmental losses on an ad hoc basis, and has been used to establish the figures in damage schedules, its apparent flaws will be discussed here in some detail.

The fact that CV studies are generally unable to elicit meaningful WTA (rather than WTP) measures (Cummings et al. 1986; Arrow et al. 1993; Schulze 1993) should be enough to preclude the use of CV for most environmental valuation situations. However, the method is still widely accepted, even for use when WTA is clearly the appropriate measure. For instance, in a proposed rulemaking issued in 1994, USNOAA

---

[21] The United States National Oceanic and Atmospheric Administration (USNOAA) reports that, as of 1994, there were more than 1400 documented papers, reports and books on CV (United States 1994b, p. 1142).

acknowledged that WTA is generally the right measure of environmental losses, but approved of the use of CV for loss assessment; simultaneously recommending against attempting to use CV to measure WTA, "because of a concern for the reliability of current procedures for eliciting WTA" (United States 1994b, p. 1146).[22]

Aside from using the inappropriate WTP measure to assess losses, CV surveys also may fail to measure WTP accurately. At least three significant problems have been identified: hypothetical bias, anchoring bias and embedding. Hypothetical bias refers to differences between the values expressed by respondents in hypothetical CV questionnaires and the values expressed for similar assets with other measurement methods. Respondents seem to overstate willingness to pay in hypothetical markets, perhaps because they know that real dollars will not change hands (Cummings et al. 1995).

Anchoring (or "starting point") bias describes the tendency of CV respondents to be influenced by the dollar amount that is suggested in the initial question asked. For example, when individuals are first asked if they would be willing to pay $5.00 for an asset, then asked if they would pay $10.00, fewer are willing to pay the higher sum than when the order of the questions is reversed (see Knetsch 1994b). Closed ended (or referendum) format questions, in which each respondent is only asked about one sum but different sums are used for different respondents, are also suspect. Responses to surveys in this format tend to be unduly high, and the proportion of respondents who are willing to pay for an asset does not change as much with different prices as might be expected,

---

[22] The reference operating conditions for CV use proposed by Cummings et al. (1986) also include a recommendation that CV not be used to garner WTA information.

20

when compared with other methods (see, for example, Kealy and Turner 1993; and Desvouges et al. 1993)

Embedding occurs in CV studies in two forms. The first, called "regular embedding," is described by Kahneman and Knetsch (1992a, p. 58) as follows: "the same good is assigned a lower value if WTP [willingness to pay] for it is inferred from WTP for a more inclusive good rather than if the particular good is evaluated on its own." Thus, respondents seem to be willing to pay more for an asset (for example, all of the fish in a lake) when it is offered separately, than they are willing to pay for that asset when it is first offered as part of a group of assets (for example, all of the fish in a lake as part of a group that includes all of the lakes in a region). Kahneman and Knetsch (1992b) distinguish a second form of embedding, called "perfect embedding," which "refers to the common tendency of people to give similar WTP responses to more or less inclusive goods . . ." (Knetsch 1994b, p. 360). Continuing with the example of valuing the fish in a lake, respondents seem to be willing to pay a similar amount to save all of the fish in one lake as they are willing to pay to save all of the fish in a group of lakes, even though the group of lakes includes the original lake.

Some analysts believe that the flaws of CV exposed by empirical studies are artifacts of study methods, and can be cured with improved technique and compensating adjustments (Arrow et al. 1993).[23] But the body of empirical evidence to the contrary is increasing, and as suggested by Bohm (1994, p. 39):

> . . . although we know a lot more about CVM [contingent valuation method] than we did some ten years ago, we have not been able to identify

---

[23] CV has even received court approval in the United States for use in environmental damage assessment (Ohio v. United States Department of Interior).

a design that would remove the original doubts about CVM, especially with respect to 'strategic bias' and 'lack of sincerity.'

CV continues to produce figures of disputable validity, and remains complex and costly.[24] The suggestion has been made that responses to CV questions reflect the "warm glow" that a respondent gets from contributing to a particular cause, rather than actual values for the environmental assets under consideration (Kahneman and Ritov 1994; Kahneman and Knetsch 1992a).

4. Incommensurable values

Implied in all of the economic approaches to environmental valuation is the assumption that accurate measurement of dollar values for non-pecuniary environmental assets is an attainable goal--it is just a question of finding the right method, or "sorting out the bugs" in existing methods. There may, however, be a more fundamental problem. Some scholars claim that human values for components of the natural environment are incommensurable; that they cannot be expressed in a single metric, and particularly not in monetary terms. A full consideration of the arguments for and against value incommensurability is beyond the scope of this paper, but some aspects of the debate will be reviewed in order to underscore the potential implications of this issue for environmental valuation.

Several recent articles by philosophers and legal theorists have addressed the concept of incommensurability and its treatment in judicial processes.[25] In a comprehensive and often cited work on political theory titled "The Morality of Freedom,"

---

[24] Disputability is a significant weakness for a methodology used in making assessments that may be challenged in judicial proceedings.

[25] See, for example, Raz (1986), Regan (1989), Anderson (1993), Pildes and Anderson (1990), Pildes (1992), Warner (1992), Radin (1993) and Sunstein (1994).

Raz (1986, p. 322) offers the following definition: "A and B are incommensurate if it is neither true that one is better than the other nor true that they are of equal value." He argues that incommensurability is displayed when people are intransitive in their choices among options; in other words, that intransitivity does not necessarily imply irrationality or hidden preferences, but instead may "reveal belief in incommensurability" (Raz 1986, p. 325).[26]

Warner (1992) discusses incommensurability in terms of justifications for different actions. Incommensurability occurs when someone is unwilling to make trade-offs between the justifications for doing different things. In other words, because of incommensurability, some reasons will not even be considered as justifications for some actions. In fact, the refusal to consider certain justifications is characteristic of the way in which some values are held (most people, for example, feel that extreme hunger does not justify cannibalism). In Warner's words (p. 157): "the nature and extent of the value one places on something is in part defined by what reasons one's evaluative attitude allows and disallows." Warner's theory provides a possible explanation of why some people respond to environmental valuation questionnaires with protest answers--they are not willing to consider the comparisons or tradeoffs proposed (see Sunstein 1993, pp. 248-253, for a discussion of this issue). It may be characteristic of the way that some people

---

[26] Tversky (1969 --*check page number*) uses a similar argument in explaining intransitive responses to psychological preference surveys:

> But guessing is not the only explanation, for their may be no valid ordering of the three objects when they differ markedly. Their merit may depend on more than one characteristic, and it is then somewhat artificial to attempt an ordering on a linear scale. Under these circumstances, the judge must mentally construct some function of the relevant characteristics and use this as a basis for comparison. It is not surprising that in complicated preference studies the function is vague and may change from one paired comparison to the next, especially when different pairs of objects may cause the judge to focus on different features of the objects.

value aspects of nature that they are not willing to consider a need (or desire) for money, or for the things that money can buy, as a reason to allow those aspects to be damaged or destroyed.

Advocates of a more utilitarian philosophy argue that observed difficulties in making certain types of comparisons do not necessarily imply that values are incommensurable. For example, Regan (1989) suggests that a refusal to consider trading-off a given entity for money is probably based on a judgment that the value of the entity is "incomparably greater" than money. The difference in approach is significant--if it is possible for entities to be incomparably different in value, but not incommensurable in a broader sense, then the belief that there is one dimension of value in which all entities can be aligned (which belief is fundamental to utilitarianism and to most economic valuation methods) remains intact.

In contrast, Pildes and Anderson (1990, pp. 2146-2147) claim that although some entities are incomparable in the manner suggested by Regan, others are incomparable in a more complex way:

> Some public values are "hierarchically" incommensurable with others, meaning that the incomparably higher regard for one value over the other is expressed by refusing certain types of trade-offs between the two. . . .

> Other public values are "radically" incommensurable with one another. In these cases, individuals cannot form confident judgments of the relative worth of options or cannot agree on the values at stake in the options. Choices, however, still can be, and are, made. Because rational preferences need be consistent only if they express such judgments of relative worth, preferences and choices among radically incommensurable values need not be consistent.

According to Sunstein (1994, p. 780), there are two aspects to the issue of incommensurability: i) humans value things in different ways, which cannot be combined into a single dimension; and ii) human goods are not commensurable, in other words, they cannot be ranked according to a single metric. He considers the difference between

24

the way in which someone values (or worships) a deity and the way in which someone values a good hammer to be an illustration of the first aspect: "Every kind of valuation embodies a qualitatively distinctive judgment or response" (Sunstein 1994, p. 783). Accordingly, valuations vary between individuals, and change in different contexts and at different times.

The second aspect of Sunstein's analysis deals with incommensurability of the sort that Pildes and Anderson define as radical. "Incommensurability occurs when the relevant goods cannot be aligned on a single metric without doing violence to our considered judgments about how these goods are best characterized" (Sunstein 1994, p. 796). But Sunstein also accepts that incommensurability does not preclude comparison or choice, it just precludes the use of a single metric as the mechanism for comparison. Choices between incommensurable options may change in different contexts or circumstances, but often those choices can be rationally and consistently made in a given context and set of circumstances. This distinction is extremely relevant for the present discussion of a ranking matrix and interim damage schedule founded on individual choices between non-pecuniary environmental assets or losses.

The debate about whether or not values are incommensurable has carried on for centuries, and, as yet, there is no empirical proof available to finally decide the issue. But recent behavioral research into individual decision making suggests that incommensurability may in fact exist. For example, studies have found that people treat choices between assets or actions differently when the relevant facts are presented in ways that cause them to allocate those choices or assets into different mental accounts (see Thaler 1991a). The disparity between WTA and WTP measures may also reflect incommensurability between losses and gains.

If incommensurability does exist, it presents a major problem for attempts to ask people to express non-pecuniary environmental values in dollar terms. However, if social decisions are to be rational, some basis must be found for making choices between reasons, values and goods at the social level, whether or not they are incommensurable-- and at the individual level, choices *are* in fact regularly made between a wide variety of seemingly incommensurable reasons, values and goods. Indeed, Raz (1986), Pildes and Anderson (1990) and Sunstein (1994) all acknowledge that incommensurability does not preclude rational individual choices. The problem (and this is a problem for all areas of policy) is to find more valid ways of determining and aggregating the value attributes that motivate specific choices and trade-offs, so that social policies reflect aggregate will.[27]

---

[27] Note that the preferences and values of individuals when dealing with social choices may differ from their preferences and values with respect to individual choices--it is the former that are the appropriate criteria for social policies (see Sunstein 1993).

III. Existing Damage Schedules

The issues discussed in the previous section arise because human values for the natural world are varied and complex. Efforts to assess the worth of non-pecuniary environmental assets solely in monetary terms ignore much of this complexity and may, therefore, be unable to accurately assess many non-pecuniary values. It is not surprising that policy makers have considered alternatives.

Compensation schedules have been promoted as an alternative that at least standardizes and improves the efficiency of damage assessment. In this section some examples of existing or proposed compensation schedules are examined, to show how the concept is currently being used. It will be seen that the idea of specifying in advance the amount required to be paid as compensation for a non-pecuniary harm, varying in accordance with the magnitude of the harm, is not new, nor is it unique to environmental valuations.[28]

1. Workers' compensation schedules

Under the typical workers' compensation scheme, the compensation that employees can recover for workplace injuries is limited to "scheduled" amounts, which vary with the severity of the injuries suffered.[29] Although originally intended to compensate only for

---

[28] See, for instance, the definition of the term "wergild" in *Websters Third International Dictionary of the English Language* (1986, p. 2597): ". . . the value set in Anglo Saxon and Germanic law upon the life of a man in accordance with a fixed scale increasing from the churl to the king and paid as compensation to the kindred or lord of a slain person or as a fine for some serious crime . . ."

[29] As an illustration, the damage schedule established by the Workers' Compensation Board in British Columbia, Canada, specifies a maximum possible award for cases of total disability, and awards 2.5% of that maximum for the loss of a little finger; 15% for the loss of a kidney; and 35% for a frozen (immobile) shoulder (British Columbia).

economic losses, workers compensation schemes have subsequently been expanded in most jurisdictions, implicitly or expressly, to include the non-pecuniary losses of pain and suffering.

The policy tradeoffs inherent in workers' compensation schemes are more extensive than those related to the assessment of damages alone. Generally, the rights of an employee to sue an employer or fellow worker for personal injuries suffered at the workplace, and to have an ad hoc assessment of the value of her injuries, are traded off for guaranteed, "no-fault," administrative recovery of an amount specified in the damage schedule. Although the employee sacrifices the chance of receiving a windfall award in litigation, she gains by not being at risk of a lower than average assessment of the value of her injury, by not having to prove that the employer's negligence caused the harm, and by being assured of a pool of funds from which to collect her award. The employer gives up the ability to defend individual claims on the basis of fault, but gains by avoiding some of the expenses of defending claims, by being protected against windfall decisions, and by being able to participate in what is effectively a group insurance program.

From a broader policy perspective, the transaction costs and incentive mechanisms of the tort liability system are replaced by an administrative system, which sets workplace safety standards, regulates compliance, and administers the pooled compensation funds. The risks and costs of workplace injuries are, to some extent, transferred to the employers who carry on the potentially injuring activities. Financial incentives and deterrents for employers are also provided, by adjusting employer contribution requirements in accordance with workplace safety records, and by setting premiums in accordance with "experience ratings" based on the history of actual claims

28

attributable to different industrial groups or firms (a growing trend in many jurisdictions).[30]

Workers' compensation schedules are directed mainly toward compensation for pecuniary loss, and cannot, therefore, be compared directly to non-pecuniary environmental damage schedules. However, broad acceptance of workers' compensation as a policy mechanism indicates that ranking extremely difficult-to-value losses in terms of relative importance, and assigning monetary figures to those rankings, can be acceptable to the public, under the right circumstances.

2. Other tort reform initiatives

Schedules of personal injury losses have been used in other areas of tort law as well, most commonly as a component of no-fault automobile insurance schemes (see King 1987). Brown and Seto (1988, p. 125) describe the schedules that have been implemented in Canadian no-fault automobile insurance jurisdictions that provide compensation for non-pecuniary losses:

> . . . these no fault schemes provide benefits only for objectivity [sic] ascertainable impairment. This is done chiefly to reduce uncertainty and disputes (and thereby costs), but it is also probably true that in many cases the degree of impairment is a fair reflection of the relative pain, suffering and loss of enjoyment.
>
> The device used is a detailed schedule of impairment or disfigurement which assigns to each form of such impairment or disfigurement a percentage thereby indicating the degree of impairment of the whole body it is deemed to represent. That percentage is applied to a given maximum to determine the amount of the award.

---

[30] But see the comments of Cane (1987, pp. 535-536) as to the questionable effectiveness of these incentives.

New Zealand has taken personal injury damage scheduling considerably further, by replacing all tort liability with a statutory compensation scheme, including a compensation schedule that encompasses non-pecuniary losses.[31]

Tort reform in the United States has been less dramatic.[32] The jurisdictions that have implemented no-fault automobile accident law schemes have tended to leave recovery of non-economic damages to the traditional tort law system (although it is common to restrict the right to pursue non-economic damages to claims above a "threshold" of significant injury or dollar amount involved [King 1987]). Many states have, however, established caps on awards for non-economic damages, or on all damage awards, particularly in medical malpractice cases (Bovbjerg et al. 1989). According to Fleming (1988, p. 25) the motivation for restricting these awards has generally come from:

> . . . the casualty insurance companies, in alliance with the medical profession, manufacturing industry or local government, depending on the issue. Two waves of counterattack have so far occurred: the first 'medical crisis' of the mid-1970s which resulted in statutory limits on non-economic damages and contingent fees in a number of jurisdictions threatened by a withdrawal of insurers, and the second, more general 'tort crisis' of the mid-1980's aimed at generalizing these restrictions for all tort claims as well as modifying the 'joint and several liability' (deep pocket) rule.

There is pressure for further changes to the personal injury damages system in the United States. The transaction costs of the existing approach are exorbitant--generally, far more money is spent in assessment and recovery than is paid to victims (Fleming 1988).

---

[31] The New Zealand Accident Compensation Act, No. 181 (New Zealand).

[32] Possibly due to constitutional restrictions (see Bovbjerg, 1989).

> . . . the real question is whether the American public will much longer tolerate a $68 billion system that returns 25 cents on the dollar to those who win the lottery, and nothing to those who lose.

> (Sturgis 1985, p. 19)

In addition, the extreme variability of jury-determined awards for non-pecuniary harm has been questioned:

> Legal reformers have long argued that present law, when combined with jury discretion, inflates damage awards and creates problematic outcome variability. The open-ended and unpredictable nature of tort exposure has, in turn, threatened the liability insurance system that funds most tort compensation. Determination of awards on an ad hoc and unpredictable basis, especially for "non-economic" losses, also tends to subvert the credibility of awards and hinder the efficient operation of the tort law's deterrence function. Moreover, award levels differ significantly by type of legal action, with claims sounding in medical malpractice and products liability theories resulting in greater compensation than claims arising from automobile accidents for similar injuries.

> (Bovbjerg et al. 1989, p. 908)

To support their claims, Bovbjerg et al. (1989) classify 366 unpublished jury verdicts from Florida and Kansas in terms of dollars awarded versus severity of injury. Although the means and medians of the awards for non-economic damages associated with each injury level generally increase with severity of injury, the awards within each level of severity are highly variable. Bovbjerg et al. recommend three alternatives for standardizing non-economic personal injury awards: i) specify an award matrix for non-economic losses; ii) provide juries with "injury scenarios" describing a range of typical injuries and the appropriate amounts to be awarded for each, to be used as boundary lines to assist jury discretion; or iii) establish a series of caps and floors on injury awards, based on severity of injury classes.[33]

---

[33] See also Levin (1989) and Blumstein et al. (1991) for similar proposals to standardize personal injury awards.

The difficulties experienced in assessing non-pecuniary personal injury losses in tort cases are similar to those encountered in assessing non-pecuniary environmental losses.[34] The variability of jury awards for non-economic value in personal injury cases may reflect the inability of jurors to express values for human injuries in dollar figures:

> The sheer fact is that there is no objective yardstick for translating non-pecuniary losses, such as pain and suffering and loss of amenities, into monetary terms.
>
> (Dickson, J., in Andrews v. Grand & Toy, p. 261 S.C.R. and p. 476 D.L.R.)

Incommensurability of value types and incommensurability of valuation in different settings may be operating. Systematic variability arising from contextual differences among cases is relevant, but variability arising from an inability to express values in dollar terms interferes with consistent compensation.

The personal injury ranking matrix proposed by Bovbjerg et al. (1989) resembles that proposed herein for environmental losses, but their matrix is based on past awards rather than comparative rankings. If part of the variability in jury awards is due to value incommensurability, then a matrix based on past awards may institutionalize errors, rather than progressing toward an expression of real values.

3. Environmental value schedules

i) Replacement cost tables and civil penalties

---

[34] Note that for personal injury pain and suffering losses, juries in the United States must make value assessments without the benefit of expert evidence or reference to previous cases, whereas for environmental losses expert value testimony is sanctioned (see, for example, Ohio v. United States Department of Interior). Thus, the pressing demand for economists to measure environmental losses, without a corresponding demand for economists to measure the value of pain and suffering losses. The practice of personal injury award determination differs in other countries (see Fleming 1992, pp. 236-237 for examples).

Turning now to environmental losses, several "scheduling" initiatives, designed to standardize natural resource damage assessments and reduce costs, have been implemented in the United States. A survey of state fish and game departments and state Attorneys General conducted in 1978-1979 (and updated in 1981) shows that the idea of scheduling natural resource values was not unusual even fifteen years ago (Halter and Thomas 1982). At the time of that survey, nine states had formally adopted fish damage schedules based on replacement cost calculations, and an additional thirteen states used value tables as a guide for assessing damages, although the schedules had not been formally sanctioned. By pre-establishing and standardizing the amounts to be charged on a per organism basis, replacement cost tables of this type make damage assessments more consistent and less costly. However, they do not avoid the problems associated with using replacement cost as a measure of values for non-pecuniary environmental assets.

Rather than attempting to standardize estimates of value, some jurisdictions instead set arbitrary monetary charges for lost fish and wildlife. Halter and Thomas (1982) report that, at the time of their survey, South Dakota and Wisconsin had established civil penalties of this type for illegally taking wildlife. "The amount charged . . . generally does not purport to represent any actual 'value' of a given species" (Halter and Thomas 1982, p. 21). Although Halter and Thomas describe such penalties as liquidated damages, if the amounts charged are not intended to be pre-estimates of the value of the losses, the charges are better described as civil fines.

The use of replacement cost tables and civil penalties for wildlife losses has expanded in the United States since the time of the Halter and Thomas survey. The 1993 version of the *State Wildlife Laws Handbook*, published by the Center for Wildlife Law at the University of New Mexico, observes:

In addition to criminal penalties, over one-third of the states have civil liability provisions of some kind ... Although it is difficult to assess the value of wildlife, half the state legislatures have assessed a value of wildlife for civil liability purposes. These states list the value of various important wildlife species and require the violator to pay restitution to the state for the value of each such animal taken.

(Musgrave and Stein 1993, p. 30)

In addition, in some states these pre-established charges for environmental harms are based on measures of value that are more extensive than replacement cost. For example, according to Plante et al. (1993), Texas ranks species pursuant to a set of eight criteria of value (such as recreational, aesthetic, economic and ecological), and then converts the rankings to a monetary liquidated damages scale.

ii) More extensive (liquidated damages) value schedules

The liquidated damages model has also been applied to the assessment of environmental losses arising from spills of oil or other damaging liquids, by specifying damage assessment formulae in terms of the type and volume of liquid spilled, and the type of environment affected. At least four examples of volume-based damage valuation schedules exist in the United States: Florida's Pollutant Discharge Natural Resource Damage Assessment Compensation Schedule (Florida); Washington State's Preassessment Screening and Oil Spill Compensation Schedule Regulations (Washington State); the "Type A" assessment computer models established under CERCLA (United States (b)); and the compensation formulae that were proposed by USNOAA in January, 1994, for use under OPA (United States (c) and United States 1994b).[35] A similar

---

[35] The proposed USNOAA compensation formula proposal has subsequently been abandoned in favor of an approach based principally on restoration or replacement (United States 1995).

volume-based damage assessment statute was proposed in New York State in March, 1994, but was not approved (New York State).[36]

The federal volume-based assessment schedules in the United States do not attempt to express all values for environmental assets. The compensation formulae proposed by USNOAA, for example, were designed to provide "an estimate of damages per gallon taking into account average restoration costs, plus average lost direct use values pending restoration" (United States 1994c, p. 13). Passive use values were not included (United States 1994b). USNOAA gave the following justification for this omission:

> Passive use (nonuse) values are currently not included in the formulas, since, at the time of their development, NOAA determined that sufficient information did not exist concerning average passive use values, applicable to the compensation formula approach.
>
> (United States 1994b, p. 1119)

Non-use values were also omitted from the original CERCLA Type A damage assessment computer models (Grigalunas and Opaluch 1988) and, in light of USNOAA's determination, it seems unlikely that non-use values will be included in the revised versions of the CERCLA models currently being developed.

Another troubling aspect of the compensation scheme that was proposed by USNOAA is that the formulae were based on data derived from traditional economic valuation methods, including contingent valuation surveys of use values (see, for example, Welsh et al. 1993). It seems likely that the final versions of the new CERCLA

---

[36] Alaska has also established volume-based charges for oil spills, but the charges are expressed as civil penalties, and it is not completely clear whether those penalties are intended to represent environmental values (Alaska (a) and Alaska (b))--although this may be a device to discourage legal challenges to the "valuation" methodology.

computer models will also be based on traditional economic valuation methods. In summary, the federal damage schedules in the United States are not designed to establish the full relative importance of environmental harms, and may be subject to all of the potential sources of error involved in measuring environmental damages with contingent valuation and other economic valuation models. The federal schemes might expedite assessments by standardizing some value figures, but once again the flaws of traditional economic valuation have been incorporated.

Florida takes a different approach. The rationale for adopting the Pollutant Discharge Natural Resource Damage Assessment Compensation Schedule (Florida) is described by Plante et al. (1993, p.718) as follows:

> As elected officials, it was the legislature's collective opinion that they were in the best position to assign a monetary value to the state's natural resources. Recognizing that such a value may not represent the true value of the resources, it was determined that assignment of a specific value would, at a minimum, eliminate the speculative nature of the damages and provide a basis for which monies needed to restore natural resources would not be tied up in seemingly endless litigation, but would be channeled into the environment as expeditiously as possible.

The Florida schedule sets out a compensation formula in which the volume spilled is multiplied by a number of factors designed to adjust for the variation in damage that will arise from differences in spill location, pollutant characteristics and habitat factors (Plante et al. 1993). The formula is intended to substitute for total environmental values: Plante et al. (p. 719) assert that "the compensation schedule is based upon the loss of ecological, consumptive, intrinsic, recreational, scientific, economic, aesthetic, and educational values of injured or destroyed resources." As with the criteria used by Texas for valuing wildlife species, the recognition of different categories of value is attractive, as it allows the expression of aspects of the importance of environmental assets that may not be picked up by typical monetary estimates. However, Plante et al. (1993, p.720) also state

that the Florida multipliers are based on "restoration cost and market value-based loss of use." If this is all that was considered, significant components of value may have been missed.

Washington State's Preassessment Screening and Oil Spill Compensation Schedule seems to abandon links to economic valuation models entirely, and instead ranks spills on the basis of environmental sensitivity and the relative propensity of different types of spilled oil to cause environmental harm (Geselbracht and Logan). All marine sites in the state are classified according to seven categories of resource vulnerability: habitat; marine birds; marine fisheries; shellfish; salmon; marine mammals; and recreation. Each site is ranked for each of these categories on a scale of one to five, and each type of oil is ranked in terms of three potential kinds of adverse effects: acute toxicity, mechanical injury, and environmental persistence.

The Washington State categories and rankings are more indicative of ecological importance and sensitivity than of estimates of monetary value in the traditional sense. For example, marine fisheries vulnerability scores for the schedule were calculated using the following factors, each ranked on a scale of one to five: i) presence and usual abundance; ii) current stock condition; iii) importance to commercial fisheries; iv) importance to recreational fisheries; v) importance as a prey or indicator species; vi) normal distributional range; vii) adult sensitivity measured by depth of occurrence; viii) larval sensitivity as measured by presence and depth of occurrence in a particular season; and ix) egg sensitivity as measured by presence and depth of occurrence in a particular season (Geselbracht and Logan, p. 8). Although commercial fisheries and recreational fisheries are included in this vulnerability score calculation, they are ranked on a scale of one to five in terms of "importance" rather than monetary value, and are weighted equally with the ranking of "importance as a prey or indicator species."

37

Washington's damage schedule scheme suggests the potential for using rankings of relative importance, in various categories of value, to assess damages. But the Washington schedule falls short of assessing or expressing full social values. The value categories do not really reflect dimensions of human values; instead they deal with aspects of physical and biological importance and sensitivity. For instance, people may value marine mammals, or certain species of marine mammals, more highly than they value marine birds, but under Washington's schedule birds and mammals are emphasized equally. No attempt is made to determine how people weight different categories of biological loss, or how they weigh biological losses against other losses. How do humans compare recreational values to biological values? Under the Washington formulae, the recreational value ranking is arbitrarily worth one-seventh of the overall score, and the six other variables are all biologically oriented.

The Washington rankings were established by experts and interest groups, including: federal and state resource agencies, Indian tribes, environmental organizations and affected industries (Geselbracht and Logan). Similarly, Florida's rankings were developed by researchers and staff from the Florida Department of Natural Resources. using a nominal group technique (Plante et al. 1993). But arguably, at least under the prevailing economic view of damage assessment, the amount charged for damage to a public asset should equal the aggregate *social* value of the loss. It may be that experts and interest groups can estimate aggregate social value, but it is far from generally accepted or agreed upon. Rankings derived directly from the public might more accurately reflect true social values.[37] The next section describes and reports the results of

---

[37] This issue is addressed in Section V.

38

an empirical study designed to test one technique for deriving rankings of relative importance for non-pecuniary environmental assets directly from the public.

IV. Ranking Non-Pecuniary Losses

The existing environmental damage schedules rely mainly on limited or flawed economic methods to establish compensation figures, or at best rely on experts and interest groups to develop rankings of physical and biological importance. Although empirically tested economic measures such as replacement cost, restoration cost, hedonic pricing and travel cost methods may be useful for assessing values in the limited circumstances for which they have been proven to be valid, these measures need to be supplemented with methods that capture other components of value, and that can be used in other contextual circumstances (for instance, when WTA is the appropriate measure of value). More questionable economic measurement methods such as contingent valuation should perhaps be abandoned completely as sources of information about social values.

A significant departure from traditional economic valuation approaches may be called for--at least in the interim until better valuation measures are developed. If consistent rankings of environmental importance can be elicited directly from the public, a damage schedule based on those rankings might provide more accurate and acceptable signals about social values. This section discusses the results of an exploratory study in which survey respondents were asked to make choices between various pairs of non-pecuniary losses. The study had two main objectives: first, to conduct a preliminary test of the ability of individuals to consistently choose between pairs of familiar non-pecuniary losses of similar type, in a single context;[38] and second, to construct from their choices an aggregated interval level scaling of the relative importance of the losses, in a

---

[38] In a previous paired comparison survey of college students conducted by Peterson et al. (1994), 90% of the respondents were at least 80% consistent in ranking WTA for public and private goods, and 68% were at least 90% consistent.

form that could be incorporated into a ranking matrix and used to develop an interim damage schedule.

1. Methodology

Two independent surveys of current and former students at Simon Fraser University (in Burnaby, British Columbia) were conducted during the summer of 1994. The first survey group consisted of students in a second-year level undergraduate class in statistical methods (the "statistics students"). Those students were asked during class to complete a written questionnaire, designed to elicit rankings of various non-pecuniary losses (a copy of the questionnaire is included as the Appendix to this paper). The second survey group was made up of graduates of the Masters Degree program in Resource and Environmental Management at Simon Fraser University (the "REM graduates"). The survey of the REM graduates was conducted by mail, using an identical questionnaire to that given to the statistics students. Only REM graduates living in Canada at the time of the study were included in the survey.

The questionnaire consisted of twelve questions, arranged in two sections of six questions each. In each question two non-pecuniary losses were described, and the respondent was asked to choose the loss for which a greater amount of compensation should be paid. All of the losses described in the first section of the questionnaire were human physical injuries involving permanent impairment, and all of the losses in the second section were oil spills involving environmental damage. In each section, the pairs of losses were presented in accordance with the psychometric survey method known as "paired comparisons" (see Thurstone 1927, Guilford 1954, Dunn-Rankin 1983, Maranall 1974, David 1988 and Peterson 1994).

i) Physical impairment questions

Although the primary intention of the study was to explore rankings of environmental losses, the questionnaire began with a series of choices between pairs of human physical impairment losses. These losses were included for three reasons. First, although human physical impairment losses have a strong non-pecuniary aspect, such losses are easy to describe and relatively familiar. It was anticipated, therefore, that perceptions of the specific attributes or service flows lost as a result of each impairment would not vary widely among respondents, and that respondents would be able to understand the nature and degree of damage associated with each injury. The ability of individuals to consistently choose among familiar human physical entities could then be compared with choices made among less familiar oil spill damage scenarios. Second, the experience of choosing between familiar human physical entities in the first half of the questionnaire was expected to introduce respondents to the process of paired comparison selection, thereby reducing confusion errors in the more unfamiliar oil spill section of the questionnaire.[39] Finally, as physical impairment schedules are used in workers compensation programs, empirical rankings could be compared with those established by legislation.

In the first section of the questionnaire, respondents were given the following instructions :

> A worker who is permanently injured at the workplace may receive a one-time lump sum cash payment as compensation. The amount received varies according to the relative seriousness of the injury.

> For each pair of injuries described below, select the injury for which you think a worker should receive the greater amount of money. Do not indicate a dollar amount, just put a check beside the injury for which you think the worker should receive more money.

---

[39] This "experience factor" must be taken into account when comparing subjects' ability to choose among oil spill losses to their ability to choose among physical impairment losses.

The four physical impairment losses described were:

(1) Permanent immobility of one knee;

(2) Permanent immobility of one wrist;

(3) Permanent complete loss of hearing in one ear;

(4) Loss of the outermost segment of one index finger (pointer finger).

All possible pairs of the four losses were presented for choice, giving a total of six choices to be made between physical impairments. The order of the pairs and the position of each loss in any pair were both randomly arranged.[40]

ii) Oil spill damage scenario questions

In the second section of the questionnaire, respondents were asked to choose between pairs of oil spill damage losses. The instructions were:

> Oil spills cause environmental damage. In some cases damage payments will be paid, and the amount of these payments may vary according to the relative seriousness of the environmental damage caused by the spill.
>
> For each pair of publicly owned locations described below, select the one for which you feel that greater damage payments should be made in the event of a spill of 100,000 litres of crude oil in mid-summer. Assume that commercial and recreational fisheries are not affected by the spills, and that it takes approximately two years for all oil to dissipate or be removed from the environment.
>
> Do not indicate a dollar amount, just put a check beside the spill location for which you think that greater damage payments should be made.

The following oil spill damage scenarios were described in the questionnaire:

---

[40] The ordering of paired comparison "stimuli" may be arranged in accordance with Ross's Matrix to minimize space and time biases (Ross 1939), but randomization is also valid if both the order of the pairs and the position of the objects in the pairs is randomized (Dunn-Rankin 1983, p.16).

(1) An area at the mouth of a river with mixed sand and mud beaches and low marshes. Marine bird populations are high, marine mammal populations are high, and recreational use of the area is low.

(2) A deep bay at the mouth of a river. Marine bird populations are low, marine mammal populations are moderate, and recreational use of the area is high.

(3) A sandy ocean beach close to a city. Marine bird populations are low, marine mammal populations are low, and recreational use of the area is high.

(4) An area of open ocean on the outer continental shelf. Marine bird populations are low, marine mammal populations are low, and recreational use of the area is low.

Again, all possible pairs of the four losses were presented for choice, giving a total of six choices to be made between oil spill damage scenarios, and the order of the pairs and the position of each loss in any pair were both randomly arranged.

The descriptions of oil spill sites used in the questionnaire, and the parameters used to describe oil spill damage, were loosely based on the Washington State Compensation Schedule for Spills into Marine and Estuarine Waters, Excluding Estuarine Waters of the Columbia River (Washington State). The Washington State system was used as a model because it includes marine and estuarine conditions that are similar to those in British Columbia, and it does not use site descriptions that depend on locally defined terms, such as "state game refuges" (Alaska (b), s.75.620) or "special management areas" (Florida, s.376.1). As might be expected, respondents had difficulty interpreting such locally defined terms when used in pre-tests of the questionnaire. In order to make the questionnaire used in the present study less complex than the Washington State classification scheme, respondents were given only a brief written description of each spill site and of the relative magnitude of three characteristics of resource vulnerability: marine bird populations; marine mammal populations; and recreational use. The oil spill settings were hypothetical, but realistic, and could be numerically ranked under the Washington State scheme for comparison.

Several other factors, such as spill size (100,000 litres), oil type (crude), season (mid-summer), dissipation time (two years), and effect on commercial and recreational fisheries (none), were standardized for all choices. The intent in simplifying and standardizing oil spill and habitat descriptions was to provide sufficient information for informed choices without overloading respondents or forcing them to make variable assumptions. Written descriptions of spill sites were included in order to evoke feelings and intrinsic values, and to encourage respondents to do more than just "add up the scores" of resource vulnerability rankings. Vulnerability rankings were given in words rather than numbers for the same reasons. The spills were framed as "damage" to "publicly owned locations" in order to capture WTA, and to elicit non-use as well as use values within the given parameters.

2. Results

i) Sample size

A total of 109 statistics students completed and returned survey questionnaires. The attendance in class on the day of the survey was estimated to be roughly 130, but a number of students left when the questionnaire was being distributed, before receiving copies. For the REM graduates survey, questionnaires were mailed to 102 REM graduates, and responses were received from 52 (a 51% return rate).[41]

ii) Ordinal rankings

---

[41] As this study was not intended to obtain representative "samples" of either group of students, the response rates are not really relevant. Each group of respondents that actually returned completed questionnaires was, for the purposes of the study, a full population. Accordingly, the study results should not be interpreted as representative of statistics students at Simon Fraser University as a whole, or of REM graduates as a whole, only as representative of the group of statistics students who completed questionnaires and the group of REM graduates who completed questionnaires.

45

One of the simplest ways to evaluate paired comparison data is to derive from each set of transitive choices an ordinal ranking for the "stimuli" being evaluated (Dunn-Rankin 1983, Peterson et al. 1994). For example, if a respondent selected "knee" in three questions, "wrist" in two questions, "ear" in one question, and did not select "finger" in any question, the ordinal ranking would be "knee, wrist, ear, finger" (progressing from highest importance to lowest). Since each loss in the questionnaire was paired exactly once with each other loss (within the same section of the questionnaire), each loss had an equal chance of being selected one, two or three times. Table 1 shows the results from the physical impairment sections of the two surveys, expressed in terms of the number of respondents in each group who selected each ranking order, and the percentage of the group represented thereby. Table 2 sets out the same information for the oil spill sections of the two surveys. Figures 1 and 2 are bar graphs of these data.

Table 1

Physical Impairment Questions
(K=Knee, W=Wrist, E=Ear, F=Finger)

Ranking Selected	Statistics Students		REM Grads	
	Frequency	Percent	Frequency	Percent
K,W,E,F	36	33%	22	42%
K,W,F,E	13	12%	2	4%
E,K,W,F	12	11%	2	4%
W,K,F,E	10	9%	1	2%
W,K,E,F	9	8%	7	13%
K,E,W,F	8	7%	12	23%
Others	14	13%	3	6%
Intransitive	7	6%	1	2%
"Equal" or no choice	0	0%	2	4%
Total	109	100%	52	100%

Figure 1

Physical Impairment Questions
(K=Knee, W=Wrist, E=Ear, F=Finger)
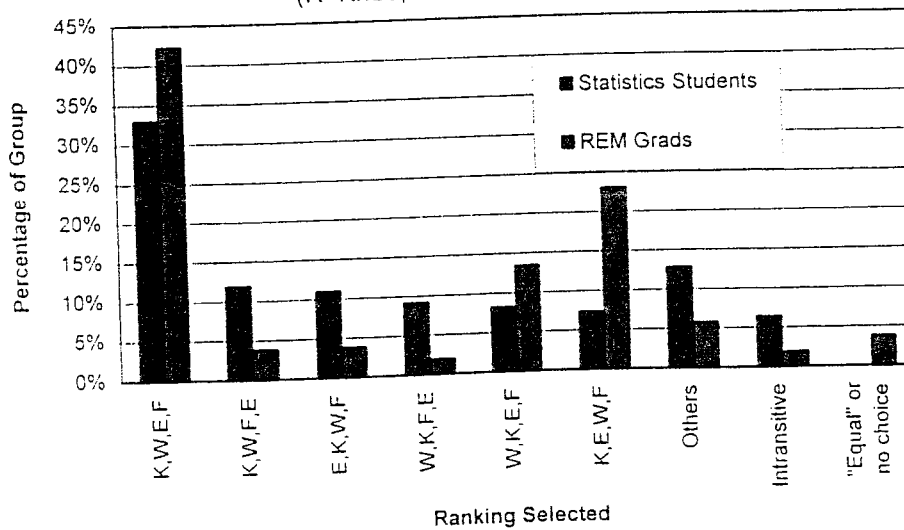
Table 2

Oil Spill Damage Questions (M=Marsh, MB=Muddy Bay, OB=Ocean Beach, OS=Outer Shelf)				
	Statistics Students		REM Grads	
Ranking Selected	Frequency	Percent	Frequency	Percent
M,MB,OB,OS	33	30%	24	46%
M,OB,MB,OS	20	18%	15	29%
OB,MB,M,OS	7	6%	1	2%
Others	32	29%	10	19%
Intransitive	16	15%	2	4%
"Equal" or spoiled	1	1%	0	0%
Total	109	100%	52	100%

Figure 2

Oil Spill Damage Questions
(M=Marsh, MB=Muddy Bay, OB=Ocean Beach, OS=Outer Shelf)
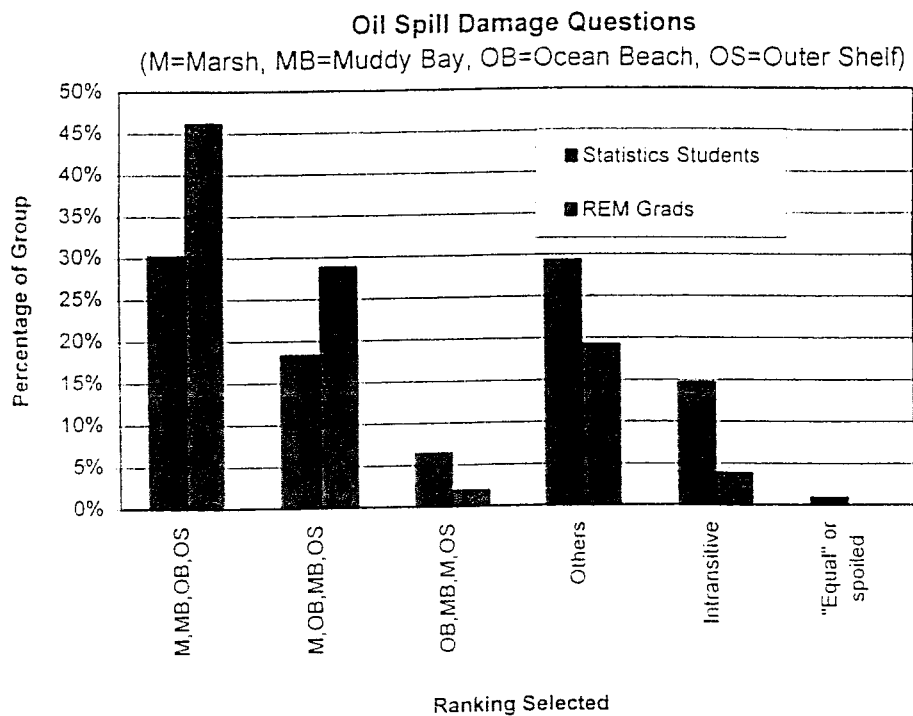
a) Physical impairment questions

No difference was distinguishable between the abilities of the statistics students and the REM graduates to transitively choose between physical impairment losses (see Table 1 and Figure 1). Although the REM graduates had only one circular intransitive response (A>B, B>C, C>A), one respondent failed to make a choice on a question and one respondent ranked two losses as equal when all other pairs had produced a preference. In total, then, 94% of the REM graduates made transitive choices between all pairs of physical impairment losses presented, as did 94% of the statistics students.

As Table 1 and Figure 1 show, the most common ranking order for both the REM graduates (42%) and the statistics students (33%) was "knee, wrist, ear, finger" (progressing from highest importance to lowest importance). The second most common ranking order for the REM graduates (23%) was "knee, ear, wrist, finger." In contrast, after the clear first choice of "knee, wrist, ear, finger," the statistics students divided relatively evenly between "knee, wrist, finger, ear" (12%), "ear, knee, wrist, finger" (11%), "wrist, knee, finger, ear" (9%), "wrist, knee, ear, finger" (8%) and "knee, ear, wrist, finger" (7%). The statistics class selected fifteen different transitive rankings, as compared to eight selected by the REM graduates.

b) Oil spill damage scenarios

In the oil spill section of the questionnaire (see Table 2 and Figure 2) the statistics students had more difficulty in making transitive choices: only 84% transitively ranked all oil spill losses, which is significantly fewer than the 94% who were transitive on the physical impairment section of the questionnaire (p=0.02), and is also significantly fewer than the 96% of the REM graduates who were transitive on the oil spill section of the

49

questionnaire (p=0.03). However, no significant difference was detected between the transitivity of the REM graduates in the two sections of the survey.

The most commonly selected rank order ("marsh, muddy bay, ocean beach, outer shelf," progressing from highest to lowest importance) was again the same for both survey groups (Table 2 and Figure 2). This ranking was selected by 46% of the REM graduates and 30% of the statistics students. The next most common ranking order for the REM graduates (29%) and the statistics students (18%) was "marsh, ocean beach, muddy bay, outer shelf." The statistics students chose a total of thirteen different transitive rankings, as compared to eight chosen by the REM graduates.

iii) Scaled rankings

Paired comparison data can be aggregated and scaled on an interval level using psychometric scaling methods. For the purposes of this preliminary study, simple aggregate scalings were calculated on the basis of relative dominance, using the "variance stable rank method" proposed by Dunn-Rankin (1965; and see Dunn-Rankin and King 1969; Dunn-Rankin 1983). The principal assumption inherent in this method is that the scale values are proportional to the sum of the ranks assigned by each of the judges to each of the stimuli (Dunn-Rankin 1983).[42] Peterson et al. (1994) used a relative dominance scaling technique similar to the variance stable rank method, and, according to Dunn-Rankin (1983 pp. 56-57), similar techniques have been proposed by Mosteller (1958), Guilford (1954) and Rummel (1964).

---

[42] Dunn-Rankin (1983, p.56) asserts that the variance stable rank method produces scale scores that are "strikingly isomorphic with values obtained under Thurstone's Case V model (Thurstone, 1927; see page 279)."

To apply the variance stable rank method, the total number of times that each loss was selected by all respondents in a survey group is divided by the maximum number of times that it could have been selected, and the result is multiplied by 100. This gives a ranking of the losses on a scale of 0 to 100, with a mean value of 50. Note that the rankings are scaled at an interval level, not a ratio level. Although forty units on the scale represent twice as much "value," or importance, as twenty units, the ratio of 80 to 40 is not necessarily the same as the ratio of 40 to 20. Also, the maximum possible score on the scale is not necessarily one hundred, and zero does not represent a complete absence of value or importance.

a) Physical impairments

Table 3 shows the physical impairment data scaled pursuant to the variance stable rank method. Table 3 also shows the percentages (of the maximum compensation award possible for the most severe workplace injury) established for each of these impairments by the British Columbia Worker's Compensation Board Permanent Disability Evaluation Schedule (BCWCB.) (British Columbia). In the column titled "BCWCB Unscaled," the actual BCWCB percentages are set out. and in the column titled "BCWCB Scaled," the BCWCB percentages have been re-scaled by multiplying each figure by 3.88. so that the median is 50 (to match the median of the scaled survey results). Figure 3 is a bar graph of these data.

b) Oil spill damage scenarios

In Table 4, the oil spill survey data have been scaled using the variance stable rank method. In order to compare the survey results to the Washington State Compensation Schedule, the non-numeric habitat vulnerability descriptors used in the survey were assigned numerical values corresponding to the Washington State ranking

scheme (five points were assigned to "high," three points were assigned to "moderate," and one point was assigned to "low"). In the column titled "Wash. Unscaled," the resulting Washington State Schedule rankings for the environmental losses described in the survey are set out, and in the column titled "Wash. Scaled," the Washington State Schedule figures have been re-scaled by multiplying each figure by 7.15, so that the median is 50 (to match the median of the scaled survey results). These data are graphed in Figure 4.

Table 3

Physical Impairment Questions--Rankings

Impairment	Statistics Students	REM Grads	BCWCB Unscaled	BCWCB Scaled
Maximum	100	100		
Knee	79	92	25	97
Wrist	66	60	13	49
Ear	39	42	3	12
Finger	15	5	1	3
Minimum	0	0	0	0

Figure 3

Physical Impairment Questions--Rankings

53
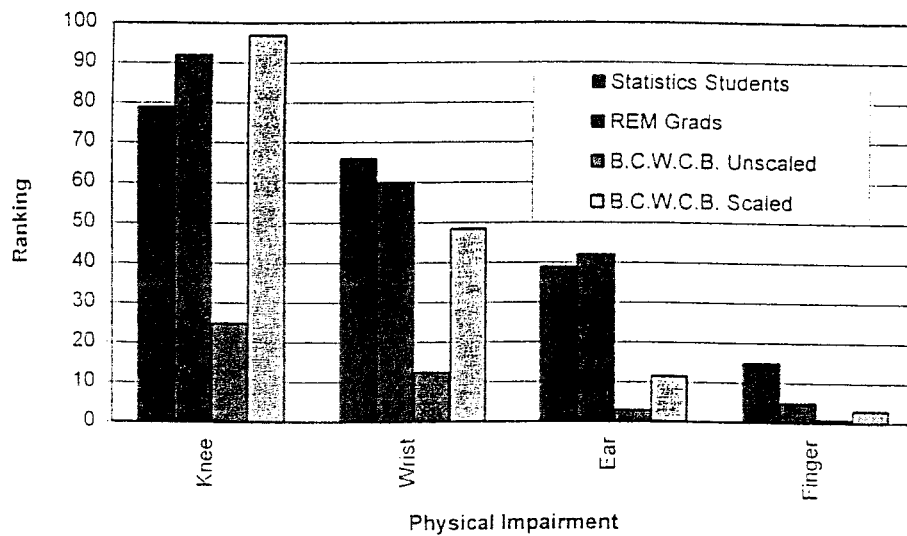
Table 4

Oil Spill Damage Questions--Rankings

Spill Site	Statistics Students	REM Grads	Wash. Unscaled	Wash. Scaled
Maximum	100	100		
Marsh	83	91	11	79
Muddy Bay	54	57	9	64
Ocean Beach	48	48	7	50
Outer Shelf	15	4	3	21
Minimum	0	0	0	0

Figure 4

Oil Spill Damage Questions--Rankings
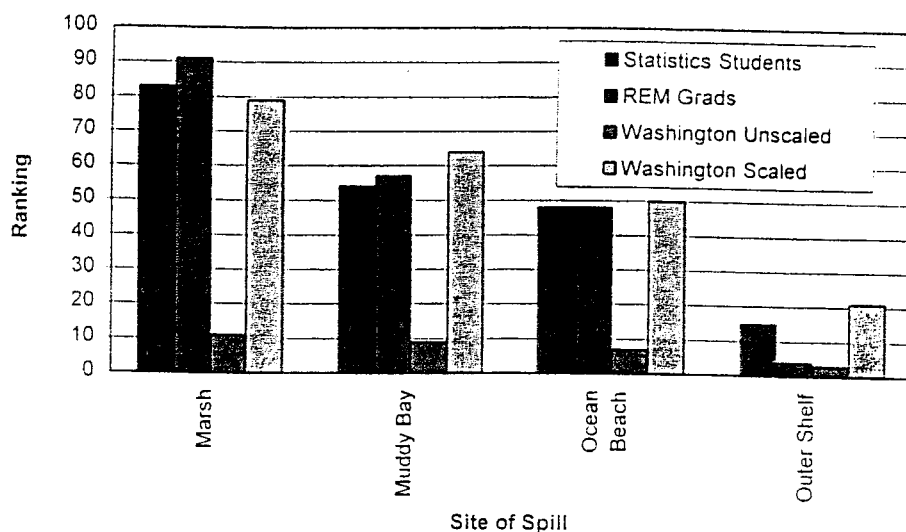
3. Discussion

i) Comparing the choices of individuals

Most of the respondents in both survey groups were able to transitively choose among all pairs of physical impairment losses and among all pairs of oil spill losses presented. This implies, at least for these two populations of students, that rational, internally consistent, choices can be made between these types of non-pecuniary losses, when the losses are familiar and of a similar type, the assets are broadly spaced in the overall spectrum of individual values, and the information given concerning the damage and the attributes of each asset is simple and easy to understand. The results compare favorably with those of Peterson et al. (1994).[43]

It is likely that individuals would have more difficulty transitively choosing between non-pecuniary losses if the losses were closer together in relative value, more complex or unfamiliar, or from more divergent dimensions of value (for example, oil spill damages compared to personal injuries). Intransitivity as a result of closeness in relative value can be used in scaling as an indication of that closeness. Intransitivity due to complex or unfamiliar loss scenarios can be dealt with, to some degree, by carefully designing the way in which information is conveyed to respondents. In the present survey, for example, oil spill losses were described mainly in terms of simple physical and biological characteristics; but if survey questions included more variation in the type of hazardous substance spilled, in spill size, or in other factors that would alter the

---

[43] In the present surveys, respondents were able to "check back" against previous answers, which would be expected to improve consistency. Peterson et al. (1994) used a computer program to administer the paired comparison choices, so that subjects could not go back to previous choices, although intransitive choices were re-submitted to subjects for a second evaluation.

55

relative effect on different resources, losses might instead be described in terms of changes in service flows (based on expert evaluations), to assist subjects in understanding those effects. Schulze [1993] recommends this technique for use in CV surveys.

Intransivity caused by divergent dimensions of value, or incommensurability, is a more difficult problem, and one which will require further empirical investigation. As will be discussed in the next section, the extent to which rational choices can be made across contexts and dimensions of value is a fundamental issue in the construction of ranking matrices, as it determines which types of assets or losses can be compared and represented in one matrix of relative importance, and which must separated into unique matrices.

ii) Comparing the choices of the two groups

The two survey groups did not show strong valuation differences in their choices; at an ordinal level, the aggregated rankings were the same for both groups and for both types of loss. This may have occurred because the two groups were not sufficiently dissimilar for such differences to appear, or because the losses were widely spaced on general scales of value; or because the losses were from similar value dimensions (physical impairment compared to physical impairment and oil spill compared to oil spill). Further investigation of more diverse groups, comparing losses from different valuation categories, might reveal such valuation differences.

The REM graduates were significantly better than the statistics students at choosing transitively between oil spill losses. It is likely that the REM graduates as a group were more experienced in environmental matters and were more attuned to environmental issues than the statistics students, and the survey differences may be a reflection of this. It is also possible that the mail survey choices were more transitive than

56

those of the in-class survey simply because of the difference in time available to review the questionnaire. The former explanation is supported by the fact that the two groups scored similarly in transitivity on the physical impairment section of the questionnaire, and the fact that the statistics students were better at transitively choosing among physical impairment losses than at choosing among environmental losses. However, it is impossible to draw any conclusion as to the source of this difference, because subjects were not specifically questioned about their interests or backgrounds (due to constraints on the time available for completing the in-class survey, and a desire to limit the length of the questionnaire).

The number of different transitive rankings selected by the statistics students was higher than the number selected by the REM graduates, for both types of loss. This difference in variance may show that the statistics class was less homogenous in values than the REM graduates, or may simply be due to the larger sample size of the statistics students group.

Overall, the scaled physical impairment loss rankings of the groups were similar to each other and to the statutory schedule rankings selected for comparison. The spacing on the REM graduates' scale between "knee" and "wrist" was wider than that of the statistics students, and was closer to that of the BCWCB schedule. Both groups ranked "ear" substantially higher in the valuation spectrum than did the BCWCB schedule, which may reflect a bias of the BCWCB schedule toward compensating working impairment rather than general loss. Although loss of hearing in one ear is a significant loss in general terms, it does not necessarily substantially impair a worker's ability to perform most job functions.

In the oil spill loss section, the scaled values of the two groups were again similar to each other and to the Washington State Schedule rankings. Not only did the order of

importance selected most often by respondents in both of the survey groups match that of the Washington State Schedule, but the scaled values also were similar. The format of the questions may have contributed to this similarity, by implying that all attributes described were of equal importance and that other attributes were not significant. The similarity, however, does at least suggest that Washington State's approach to rating oil spill losses bears a relationship to the relative values of a portion of the public. It may be that Washington's panels of experts and interest groups succeeded, in this case, in roughly estimating relative social valuations for the losses considered here.

The survey results also suggest that characterizing locations by specified habitat criteria, and describing those criteria in terms of relative sensitivity and ecological significance, is an easily understandable framework for communicating information about environmental losses to the public.

V. Developing and Evaluating a Ranking Matrix and Interim Damage Schedule

1. The concept

The study discussed in the preceding section indicates that individuals may be able to make consistent choices between non-pecuniary environmental losses, provided that the losses are of similar type and are compared in similar contexts. A method was demonstrated for aggregating individual choices to form an array of environmental losses, ranked in terms of relative importance and scaled at an interval level. This section shows how such preference rankings can be combined into a ranking matrix, including contextual and valuational dimensions observed to affect rankings. The ranking matrix can then be used as the foundation for an interim damage schedule. The discussion concludes with an evaluation of the potential of the ranking matrix and environmental damage schedule as substitutes for accurately measured values. Environmental damage assessment is emphasized in the evaluation, but the usefulness of ranking matrices in other areas of decision making is also considered.

2. Developing the ranking matrix and interim damage schedule
i) Establishing preference rankings

The first step in constructing a ranking matrix and interim environmental damage schedule is to establish preference rankings for the non-pecuniary assets or losses under consideration. The study in the previous section explored one technique for doing so. It has been suggested in this paper that assessments of social values should be founded on the preferences of lay people. However, lay preferences can be difficult to ascertain, and the opinions of experts or interest group (or stakeholder) representatives have often been used instead. Can the preferences of interest group representatives or experts be treated as accurate estimates of social preferences? A number of factors may cause divergence.

59

Some of these factors will be briefly mentioned here, in order to support the claim that empirical methods for eliciting rankings from lay people are a necessary component of attempts to assess true social values.[44]

The collection of interest groups involved in a social issue at any time may not represent a complete sampling of all of the attitudes and preferences of society with respect to that issue. Moreover, the preferences of the representatives of any given interest group may fail to accurately express the preferences of the members of the group itself. There is certainly no reason to expect that the importance attributed to an asset by an interest group's representatives will represent a statistically weighted summation of the importance that would be attributed to it by each member of the group. The preferences of the representatives may differ even from the preferences of the majority of the group's members, due to organizational incentives acting upon group leaders. Consequently, interest group representatives may not be the best source for aggregate social preferences.

Expert opinions carry other problems. Risk assessment studies have demonstrated that experts often rank the significance of events in ways that differ markedly from the rankings of lay people (Slovic 1987). But the preferences of lay people in these instances are not necessarily irrational. In some cases they may be confused, or may base their choices on erroneous facts or interpretations, but they may also differ from experts because of particular dimensions or characteristics of losses or potential events that are important to them, beyond the narrower calculations of probabilities and expected losses on which expert rankings are largely based. In other words, lay people's preferences may

---

[44] See Pildes and Sunstein (1995, pp. 43-95) for a detailed analysis of this issue, in the context of risk regulation.

express important attributes of value and perspectives toward risk that are not apparent to experts. This point is illustrated by the finding that people may be willing, on average, to spend three times as much to prevent a cancer death than to prevent an immediate death from other causes (Pildes and Sunstein 1995).

Experts strongly focus on the magnitude of an expected loss (the probability of occurrence multiplied by the value of the loss if it occurs) in assessing relative importance. Non-experts tend to consider this as only one attribute, and in addition weigh characteristics such as whether a risk is assumed voluntarily or imposed, whether it affects future generations or not, and the extent to which it is controllable by the individuals affected (Slovic 1987). Such differences in perspective are common and are important in valuing risks and losses. The disparities may result from different information, or interpretations of facts; from different subjective calculations, particularly concerning the reluctance of many people to disregard even low probability events; or from different levels of trust that cleanup activities will be as thorough or as speedy as suggested.

In the assessment of social values, lay preferences are important when real differences in valuation, rather than confusion, cause variations from the preferences of experts. As Pildes and Sunstein (1995, p. 73) suggest (in a discussion about perceptions of risk):

> If lay assessments rest on factual misinformation, or on cognitive
> distortions in the way inferences are drawn from the known facts, they
> need not be credited. But to the extent that they reflect different valuations
> of risk, such as concern for how equitably distributed a risk is, or whether
> the processes by which the risk is imposed and managed are fair, they are
> the kind of citizen preferences, backed up by legitimate reasons and
> values, that democracies should take seriously.

This does not mean that lay preferences must always be followed. The objective of determining social rankings of importance is to provide decision makers with accurate

information about social values and preferences, not to replace political decision making processes with public opinion polls. There may be circumstances in which decision makers will elect not to abide by lay preferences, but they should not have to guess at what those preferences are.

The potential for variation among the assessments of interest groups, experts and lay people suggests that, when possible, the ranking matrix should be based on preferences elicited directly from lay people. However, some effort does need to be made to minimize the distorting effects of confusion in lay judgments. A variety of methods exist for determining lay preferences; from simple surveys or opinion polls to lengthy exchanges between experts and lay people, in which factual and cognitive errors are directly addressed. The paired comparison survey discussed in Section IV falls somewhere between these extremes, as an attempt was made to convey to respondents some degree of scientific information about the magnitude of the consequences of oil spills in different environments.

For any given context, the choice of appropriate method will depend on practical experience and the complexity of the assets, occurrences or consequences being assessed. In general terms, though, an appropriate role for experts might be to provide information about the bio-physical properties or the flows of services provided by the environmental assets under consideration, the estimated consequences of the environmental occurrences selected for ranking, and the uncertainties involved, so that lay people can base their choices about relative importance on the best available information.[45] Another

---

[45] See de Grout (1992) for an example of a system that compares environmental assets on the basis of environmental functions (or "goods and services") that they provide, and see Usher (1986) for an example of a system used to weigh the relative significance of areas for wildlife conservation. The extensive research on risk communication could be used to design the mode for communicating this type of scientific information to lay rankers.

consideration in choosing a method for eliciting preferences is that increasing direct public involvement is likely to increase the credibility and acceptability of the resulting preference rankings, not only because the results are more likely to accurately reflect social values, but also because the process itself will be seen as more likely to elicit true social values.

ii) Developing the ranking matrix

Once the empirically derived social preference rankings have been established for the environmental assets (or environmental losses) under consideration, the preferences can be combined into a ranking matrix. Variables for the matrix axes should represent the parameters found in practice to significantly influence preferences, including physical criteria determined to be important in characterizing the severity of the consequences of different harms.[46] The results of the REM graduates survey described in the previous section can be used to show how preference information can be incorporated in a simple ranking matrix of hazardous substance spills. In this case, one axis of the matrix might set out the occurrence causing the environmental loss under consideration. As the REM graduates survey only considered one type of environmental occurrence and did not specify the source, the rankings expressed in that survey would all appear at one point on the occurrence axis, as shown in Figure 5.

---

[46] The matrix proposed by Bovbjerg et al. (1989) for assessing non-economic losses arising from personal injuries uses the criteria of age of the injured party and severity of the injury.

Figure 5

```
┌────────────────────────────────────────────────────────────────────────┐
│                                                                          │
│              Sample Occurrence Axis for Oil Spill Damage Matrix          │
│                                                                          │
│     Occurrence Axis                                                      │
│                              │                                           │
│          Diesel Oil Spill    │                                           │
│                              │                                           │
│          Crude Oil Spill     │    #      #      #      #      #          │
│                              │                                           │
│          Cyanide Spill       │                                           │
│                              │                                           │
│          PCB Spill           │                                           │
│                              │                                           │
│                                                                          │
└────────────────────────────────────────────────────────────────────────┘
```

Other axes might set out the location of the occurrence and the biological and recreational components associated with that location--in this case, marine birds affected, marine mammals affected and recreational use affected (see Figure 6).

Figure 6

Sample Axes for Oil Spill Damage Matrix
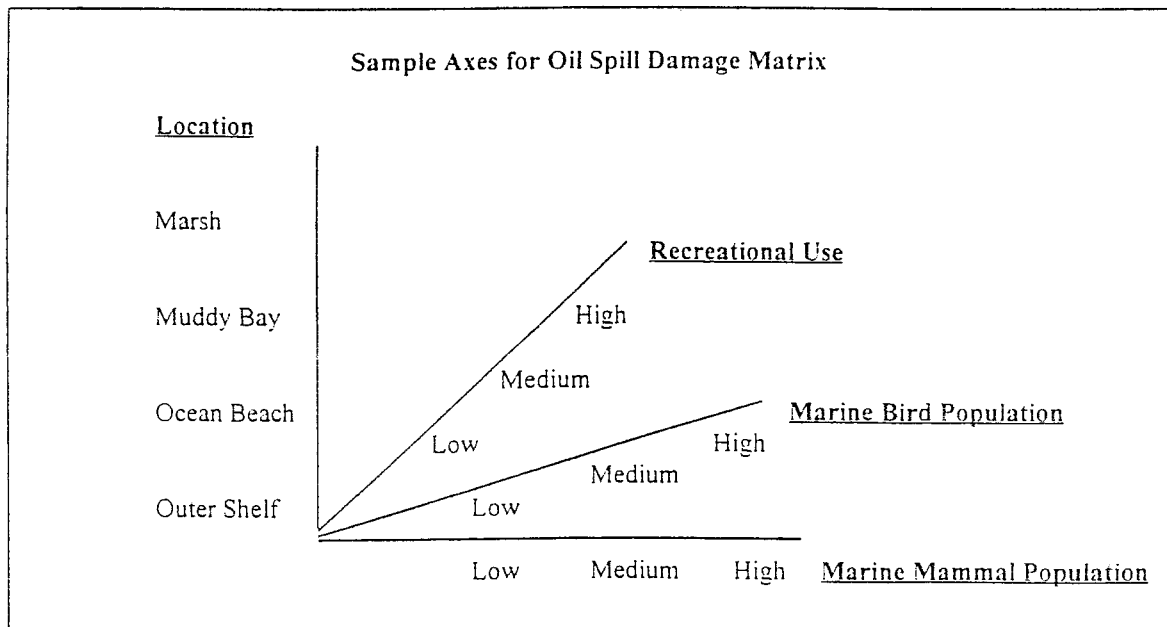
In each cell of the matrix a figure would appear expressing the scaled ranking of the relative importance of a loss with the combination of characteristics associated with that cell. Using the REM graduates survey, a relative importance ranking of 91 would appear in the matrix cell representing the following characteristics: Occurrence--crude oil spill; Quantity--100,000 litres; Season--mid-summer; Dissipation time--two years; Location-- river mouth with mixed sand and mud beaches and low marshes; Commercial fisheries-- none; Recreational fisheries--none; Marine bird populations--high; Marine mammal populations--high; and Recreational use--low. In contrast, a relative importance ranking of 48 would appear in the matrix cell representing the characteristics: Occurrence--crude oil spill; Quantity--100,000 litres; Season--mid-summer; Dissipation time--two years; Location--sandy ocean beach close to a city; Commercial fisheries--none; Recreational fisheries--none; Marine bird populations--low; Marine mammal populations--low; and Recreational use--high.

The principal advantage of expressing preference results in a multi-dimensional matrix is that a variety of contextual and valuational characteristics can be portrayed. It is possible, for example, that people will say that the loss of one hundred marine birds caused by a spill of radioactively contaminated water is worse than the loss of the same number of marine birds caused by a spill of diesel oil. If so, one axis of a ranking matrix dealing with harms caused by hazardous substance spills might describe the type of substance spilled. Note that the need in this instance for a separate axis describing the spilled substance does not arise solely from a difference in the biophysical consequences of the two, but from a difference in valuation of two different types of occurrence that produce the same ultimate biophysical consequences. Similarly, it may be found that people feel that the loss of one hundred marine birds caused by a spill of diesel oil arising from a tanker ship is worse than the same loss arising from a pipeline or from an oil

65

refinery. Accordingly, a ranking matrix dealing with both types of loss should include an axis in which the source of the hazardous spill is described.

A related advantage of the ranking matrix is that perceptions about the risks of potential occurrences are incorporated in the preference judgments and can be expressed as dimensions in the matrix. For example, a variation between the importance attributed to a loss of fifty marine birds caused by an oil spill, as versus the same loss caused by radiation exposure from a nuclear power plant failure, might reflect not only a differences in valuation of the types of occurrence, but also a difference in perceptions of the risks involved. As risk studies indicate that unusual, highly uncertain, and catastrophic events are disproportionately weighted by lay people, axes might be designed to distinguish these variables. The examples described here are intended only to give an idea of how the matrix might be structured--the parameters that actually influence rankings will need to be empirically explored in different contexts.

All possible types of losses could not possibly be ranked initially, but as long as a framework of a few typical reference points was established, other points could be filled in with experience, by interpolation and extrapolation from those previously ranked. For example, if the initial ranking matrix included the ranking described above for a crude oil spill at a sandy ocean beach, and in fact an identical crude oil spill occurred in an area with similar characteristics except for the presence of a moderately high population of marine birds, the unranked spill might be assigned a higher importance than the ranked spill. If, instead, the spill was in a similar area with low marine bird populations and low recreational use, the new spill might be assigned a lower importance than the ranked spill. In either case, the importance assigned to the new spill would then provide an additional point within the ranking matrix for use in later comparisons.

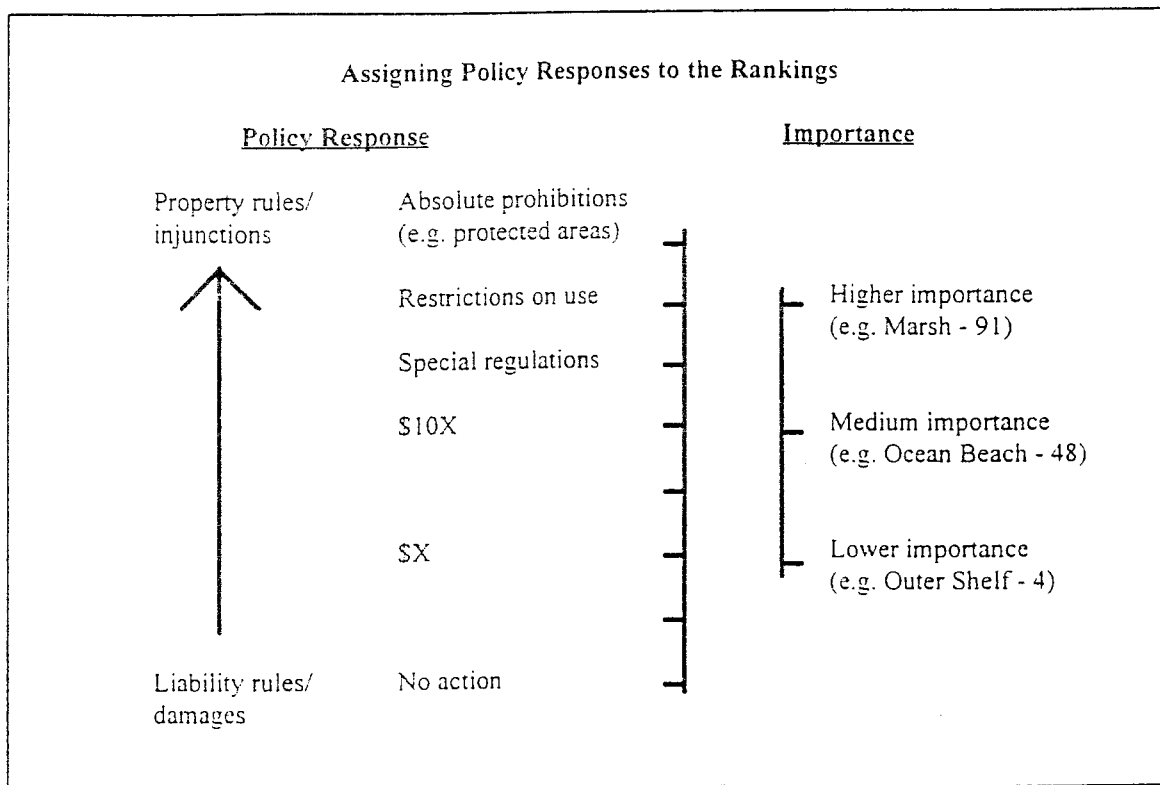iii) Developing the interim damage schedule

66

To construct an environmental damage schedule from the ranking matrix, the ranking scheme would be assigned a "location" within the overall range of dollar values and other policy measures contemplated as remedies. The assigned remedies need not be limited to dollar amounts to be charged for damage; other policy measures could be assigned where indicated by the relative importance of the environmental assets at stake.[47] At one end of the spectrum of available remedies might be policies that absolutely prohibit use of, or damage to, environmental assets. For example, oil tanker shipping might be prohibited in areas that are very highly ranked in terms of relative importance. At the other end of the spectrum of remedies might be small fines for damage, or small charges for use. These could be assigned to environmental assets ranked at the low end of the range of relative importance.

Figure 7 shows how a selection of potential policy responses could be allocated to a set of relative importance rankings. In the center of the figure the available policy responses are laid out, ranging from the least severe at the bottom to the most severe at the top. In this case, the less severe responses involve liability rules, requiring the payment of damages for harm. The more severe responses impose property rules, protected by absolute prohibitions on use, backed by injunctive remedies. On the right side of the diagram the scaled rankings of the REM graduates are set out . Based on those rankings, the least severe remedy would be assigned to the Outer Shelf oil spill location and damage description, and the most severe remedy would be assigned to the Marsh oil spill location and damage description.

---

47 See Calabresi and Melamed (1972) for a discussion of the logic underlying allocations of property rights and liability rules in varying circumstances.

67

Figure 7

Assigning Policy Responses to the Rankings

Policy Response   Importance

Property rules/   Absolute prohibitions
injunctions   (e.g. protected areas)

                       Restrictions on use   Higher importance
                                                           (e.g. Marsh - 91)
                       Special regulations

                       $10X   Medium importance
                                                           (e.g. Ocean Beach - 48)

                       $X   Lower importance
                                                           (e.g. Outer Shelf - 4)

Liability rules/   No action
damages

The assigned location within the array of possible remedies would necessarily be arbitrary, as true values would not be known.[48] In other words, although the ranking matrix indicates that the Ocean Beach should be assigned a remedy that is approximately ten times as severe as the Outer Shelf, this is only scaled relative information; the socially correct remedies in absolute terms are unknown. It is for this reason that the damage schedule should be designated as "interim"--to indicate that it is intended that the schedule will be adjusted with experience, with shifting social values, and with credible

---

[48] In Washington State, for example, the legislature arbitrarily imposed a range of $0 to $50 per gallon spilled, which was then applied to an established ranking scheme (Geselbracht and Logan).

68

new value information. Ideally, both the overall location of the range of rankings within the range of remedies, and the spacing of rankings, would be continually adjusted until socially desired outcomes occur. The term "interim" might also help to forestall changes in individual valuation reference points that could be expected over time with a schedule perceived as permanent. It must be clear that the initial damage schedule is not intended to depict the absolute social "worth" of the assets described; otherwise, the damage figures in the schedule might come to represent to society the absolute values of those assets.

3. Evaluating the concept

It has been established that damage schedules simplify and expedite the assessment of damages. But to what extent could a ranking matrix of relative importance, and an interim damage schedule based on that matrix, actually substitute for measured values? Recall from Section I that accurately measured values provide information used in allocating resources, assigning the right prices to non-market assets and assessing damages. The ranking matrix and interim damage schedule can now be evaluated in the same roles.

i) Allocation decisions

Like accurately measured values, a matrix of relative rankings would provide decision-makers with the information required to weight non-pecuniary environmental assets in accordance with aggregate social perceptions of relative importance, at least within a given context and in comparison with other assets ranked in the same matrix. Weightings based on matrix rankings might not be optimal, particularly in the initial stages when the matrix was necessarily less comprehensive. But at least that information about relative values that could be elicited from the public, based on the best available factual data, would be provided to decision makers in advance of decisions being made. More comprehensive rankings should evolve with time and experience. To the extent that the

69

ranking matrix is accepted as a valid reflection of public opinion (and this would depend in part on the quality of the empirical work on which it was founded), allocation decisions would be more defensible, and conflicts might be reduced. Environmental management, restoration efforts, and industrial development could all be more appropriately targeted, with respect to the assets that fit within the ranking matrix.

Because of the necessarily arbitrary assignment of prices and remedies to the matrix rankings, allocation decisions involving non-pecuniary assets that could not be compared and ranked in one matrix, or involving ranked non-pecuniary assets and unranked pecuniary assets, would remain uncertain. In addition, if it is true that value rankings are context-dependent, the relative rankings within a matrix would only be valid for allocations in the context for which the rankings were given.

ii) Getting the prices right

Here the analysis follows along similar lines to that for allocation decisions. Assigned prices based on matrix rankings would give appropriate incentives and disincentives for choices among assets that could be compared and ranked in one matrix, but the incentives and disincentives might not be appropriate for choices among assets that could not be included in one matrix, or between ranked non-pecuniary assets and unranked pecuniary assets, or between assets in different contexts. A relative ranking matrix would, however, cut transaction costs, by reducing the time and expense involved in current efforts to determine and assign prices, and by making such price determinations certain. In some instances the savings in uncertainty cost might be greater than the incurred cost of inaccuracy. Pre-established and certain prices also would generally aid public and private decision-makers in planning their activities. Again, the currently available alternative is not an accurate assessment of values, but is instead an absence of credible valuations and a plethora of often self-serving assertions.

70

iii) Assessing damages

As discussed in Section II, there exist several different conceptions of the social justification for the practice of assessing damages against those who cause environmental harms. Absolute accuracy in assessment is not crucial under some of these conceptions. Therefore, the successfulness of a ranking-based interim damage schedule as a substitute for accurately measured values in this context largely depends on the conception of the social justification for damages that is adopted as the standard of evaluation. The interim damage schedule concept will be compared here first to accurately measured values (assuming, for the purposes of discussion, that accurate measurement of non-pecuniary environmental values could be accomplished), and then to current inaccurate estimates of values.

If non-pecuniary environmental values could be measured accurately in individual cases, then shifting from post-incident case-by-case assessment to pre-incident standardization would entail a tradeoff of accuracy in each individual case for overall expediency and cost-saving. Would such a tradeoff be warranted? Accuracy in measuring values does not, at first, appear to be essential to the objectives of the standard economic models of damages (compensating losers, paying for restoration and deterring future accidents). As long as the amount of compensation charged is sufficiently high, each of these objectives should be achieved.[49] But when the underlying goals of internalizing

---

[49] This assertion is based on the traditional economic approach to deterrence. Castle et al. (1994) themselves question the effectiveness of damages as deterrents, as do others. For example, McManus (1994, p. 118) argues that the deterrent effect of damages assessed under environmental legislation in the United States will be undermined by the magnitude of other costs faced by polluters, such as:

> . . . colossal clean-up costs, the costs of EPA's [the United States Environmental Protection Agency's] elaborate oversight and implementation of longer-term remediation, private damage claims, civil and criminal penalties (including, in the case of Section 311 of the Clean Water Act, jail time for a negligent discharge), internal costs and bad publicity. In other words, trustees' claims for injuries to natural resources can be expected to have virtually no deterrent effect."

externalities and maximizing economic efficiency are incorporated into these objectives, they are better expressed as: i) compensate losers *without over-charging winners*; ii) pay *the exact amount required, and no more,* for environmental restoration; and iii) deter future accidents *without overly deterring economic activity*. Accuracy then becomes very important to achieve desired social outcomes.

Accordingly, *if* post-incident valuation methods produced accurate valuations, then under the economic models the only justification for a shift to pre-incident damage schedules would be if the gain in efficiency was worth the costs of the inaccuracy.[50] Since the interim damage schedule approach initially involves an arbitrary assignment of dollar values (or other remedies) to assets ranked only by relative importance, awards might well be inaccurate in absolute terms until the schedule was adjusted on the basis of experience. But the relative deterrence and incentive effects with respect to assets within the schedule could still be appropriate. For example, a pre-established and publicized interim damage schedule for oil spills would encourage shippers of oil to avoid highly ranked areas in favor of lowly ranked areas, provided that other costs were similar.

If the accepted function of damages is redress, however, the analysis changes. The sacrifice of accuracy inherent in pre-incident standardization is then not as important, as long as the standardized figures fall within general bounds perceived to reflect social values fairly. A damage schedule would ensure that, when relative rankings could be

---

(And see Cane (1987) for similar arguments with respect to personal injury damages.)

[50] A perceived trade-off between efficiency and accuracy probably lies behind the fact that existing environmental damage schedules in the United States are restricted to relatively small spills. The policy makers who designed these schedules may believe that losses can properly be assessed on an ad hoc basis if enough time and money is devoted to the process; but it would not be rational to devote such resources to the damages from smaller spills.

determined, losses considered by the public to be more severe were given more compensation than those that were considered to be less severe, and that the differences in required compensation were publicly expressed in advance. Fairness requires equal treatment in equal circumstances, and the clear embodiment of this principle in a pre-established damage schedule might in itself compensate for some sacrifice of accuracy. For similar reasons, awards based on an interim damage schedule could provide solace. The degree of comfort provided by an award should be strongly influenced by conceptions of fairness and the expectations created by social norms.

Up to this point in the discussion, it has been assumed that non-pecuniary environmental values could accurately be measured in individual cases. When the assumption of accurate post-incident valuation is dropped (as it must be with current environmental valuation methods) pre-incident standardization becomes easier to justify under any conception of the role of compensatory damages. In comparison to current efforts to assess non-pecuniary environmental losses, an interim damage schedule would not only be more efficient and less costly, but it would provide more certain outcomes; and it might even be more accurate, at least in relative terms. Under an interim damage schedule, incentives and deterrents might be stronger, and decision making and planning might be more appropriate. In addition, an interim damage schedule could express rankings of relative importance in the WTA context, rather than in the usually inappropriate WTP context of most current valuation efforts.

Finally, the certainty of assigned damages would enable actuaries to better estimate the probable costs of environmental losses, making environmental liability

insurance more feasible. This, combined with less disputable damage assessments, would result in more successful recovery of environmental losses.[51]

4. A single schedule or multiple schedules?

If values are indeed incommensurable, then it is unlikely that the incommensurability is limited to comparisons between non-pecuniary assets and money. Values may, in fact, be incommensurable among many different types of assets, and in many different contexts (Raz 1986; Sunstein 1994). Therefore, although it may not be difficult for people to rank the importance of environmental assets when the assets are similar in nature and are presented in one context (for example, marine crude oil tanker spills, as in the survey discussed in Section IV), they may have more trouble ranking assets that are widely dissimilar in nature or are presented in different contexts (for example, the loss of one hectare of tall grass prairie compared to the loss caused by a crude oil spill in an ecologically rich marine estuarine environment).

For assets among which people cannot make consistent choices, or contexts across which assets cannot be compared, preferences may need to be expressed in separate ranking matrices, rather than attempting to reduce diverse values into combined scales. It seems unlikely, for instance, that the personal injury losses and the oil spill losses described in Section IV could be ranked in the same matrix. People simply may not be capable of rationally comparing the loss of the outermost segment of one index finger with an environmental loss arising from an oil spill.

Obviously, as the number of different matrices required to express relative values increases, some of the efficiencies of the ranking matrix and damage schedule concept

---

[51] This has in fact been the experience in Washington State (Logan 1994).

74

disappear. But where rational consistent choices cannot be made, decreasing the number of ranking matrices used entails important tradeoffs that are similar to the trade-offs made initially in moving from the measurement of values in dollar terms to rankings of relative importance. As rankings from differing dimensions are merged, information may be distorted or lost, and accuracy may be sacrificed in favor of reduced cost and complexity, easier choices, and increased overall efficiency.

Fortunately, a single ranking matrix might be all that is required to give appropriate relative incentives and disincentives within a single policy setting, such as assessing oil tanker spill damages. For broader policy applications, such as benefit/cost evaluation of siting options, or setting the right "prices" for non-market goods, the better information provided by multiple rankings would be more important, although more difficult to interpret. There is evidence that multi-dimensional attitude studies such as those of Kellert (1983, 1984a, 1984b, and see Kellert 1993 for a recent summary of this work), or decision-theory techniques such as multi-attribute utility analysis (see, for example, Edwards and Winterfeldt 1987), can produce scalar rankings in a variety of value dimensions. Whether weighting factors can be found to aggregate such scalar rankings into fewer dimensions, without undue distortion, is largely an empirical issue that remains to be explored.[52]

The need for multiple ranking matrices cannot be fully considered without a better understanding of the existence and extent of value incommensurability, and the ways in which it is expressed. More empirical studies are needed: of people's abilities to make

---

[52] For an interesting approach to the dimensions of human values and their importance in policy making, see the Policy Sciences literature of Harold Lasswell and his followers, in which eight types of "base values" are identified and used in a framework for policy analysis (Lasswell 1971; Brewer and deLeon 1983; Brunner 1991).

choices among more widely varying non-pecuniary environmental assets; of the effects of context on choices; and of the possibility of scaling and weighting choices from different value dimensions into more comprehensive overall rankings. However, since the existing value measurement methods simply ignore the possibility of incommensurability, a ranking matrix or matrices expressing any number of valuation dimensions greater than one might better reflect real values than do current approaches.[53]

---

[53] CV studies commonly exclude from sample groups all nil value responses and outliers, both of which may be expressions of incommensurability.

Conclusion

In 1848, John Stuart Mill complained of the courts in England: ". . . the procedure of the tribunals is so replete with delay, vexation and expense, that the price at which justice is at last obtained is an evil outweighing a very considerable amount of injustice . . ." (1848, p.243). Mill could easily have been discussing modern environmental damage assessments--but when the existing economic methods of measuring non-pecuniary values are used, it is not even clear that "justice is at last obtained." Environmental damage schedules offer a solution to problems of delay, vexation and expense. An interim damage schedule of the type proposed here might do more. When based on a matrix of scaled rankings of relative importance, such an interim damage schedule might convey more reliable information about true social preferences than is possible with ad hoc value assessment using current economic methodology.

This paper has focused on damage assessments for environmental losses. This is the most obvious application of the ranking matrix concept. Since a ranking matrix provides information about relative importance, rather than absolute values, it seems most suited to decisions involving reasonably foreseeable events which are likely to be repeated from time to time, such as oil spills. In these settings, information gathered from experience can be used to adjust the assignment of policy measures to the matrix rankings, in accordance with observed outcomes. Moreover, the rankings can be expected to evolve to become more comprehensive over time, with the addition to the matrix of new occurrences and consequences by extrapolation and interpolation. Events of this type are also likely to be more familiar to lay people, who may, therefore, have a better understanding of the potential consequences and be able to make judgments without distortion due to confusion.

I have suggested, however, that there are broader policy applications for matrices of scaled relative importance. For example, a ranking matrix might be useful when information is needed about the relative social importance attached to the consequences of alternative policy choices. A choice between two potential dam sites with different environmental and recreational characteristics might be greatly assisted by an understanding of the relative importance of the non-pecuniary environmental assets involved, particularly if social perceptions of the relative risks were incorporated in the rankings..

I have also stressed that the ranking matrix concept is being proposed as a mechanism for providing information to decision makers about social preferences, not as a substitute for political decision making and expert judgment. Even when policy objectives are established by other means. though, rankings could still be used as one measure to evaluate alternative methods for achieving those objectives. For example, if. as a result of a political decision. an international negotiation, an expert's judgment, or some other mechanism of choice. it is determined that total carbon emissions into the atmosphere should be reduced to a specific level, then the ranking matrix approach could be used to assess social valuations of the methods and consequences associated with alternative means of achieving that objective.

Ranking matrices might even assist in choices among incommensurable options. Raz (1986, pp. 335-340) asserts that choices among incommensurables are made by selecting a set of good reasons for one option, without necessarily determining that those reasons are better than the reasons for other incommensurable options. Ranking matrices would provide information to decision-makers about the relative strengths of the reasons for selecting any given option, within the range of comparables. without forcing values into a single monetary measuring unit. This moght lead to more reasoned social choices:

On monistic theories of value, it is easy to believe that nothing is really lost - or at least nothing that is unique, intrinsically valuable, or irretrievable. This understanding diminishes the incentive to find a solution that will not create tragic choices. When tragedy is understood to be present, there is a constant and conspicuous social interest in seeking choices that simultaneously promote all of the relevant goods.

<div align="right">(Sunstein 1994, p. 859)</div>

Not incidentally, the empirical process of developing a ranking matrix would provide evidence as to whether environmental values really are incommensurable, and if so, to what degree and in what contexts.

Further investigation of the abilities of individuals to make comparative choices between non-pecuniary environmental assets and losses is needed before the full potential of the ranking matrix and interim damage schedule concepts can be determined. But the results of the study reported herein indicate that consistent rankings can be obtained with simple, clearly separated losses presented in a single context, and that further exploration is justified.

References

Alaska (a). "Environmental Conservation Act." *Alaska Statutes*. Title 46, Ch.3, s. 46.03.01 et seq.

Alaska (b). "Oil and Hazardous Substances Pollution Control." *Alaska Administrative Code*. Title 18, Ch.75, s. 75.005 et seq.

Anderson, E. 1993. *Value in Ethics and Economics*. Cambridge Massachusetts: Harvard University Press.

Arrow, K., R. Solow, P.R. Portney, E.E. Leamer, R. Radner and H. Schulman. 1993. "Report of the NOAA panel on contingent valuation." *United States Federal Register* 58:4602-4614.

Blumstein, J.F., R.R. Bovbjerg and F.A. Sloan. 1991. "Beyond tort reform: developing better tools for assessing damages for personal injury." *Yale Journal on Regulation* 8:171.

Bohm, P. 1994. "CVM spells responses to hypothetical questions." *Natural Resources Journal* 34:109-120.

Bovbjerg, R.R., F.A. Sloan and J.F. Blumstein. 1989. "Valuing life and limb in tort: scheduling 'pain and suffering.'" *Northwestern University Law Review* 83(4):908-976.

Boyce, R.R., T.C. Brown, G.H. McClelland, G.L. Peterson and W.D. Schulze 1992. "An experimental examination of intrinsic values as a source of the WTA-WTP disparity." *The American Economic Review* 82:1366-1373.

British Columbia. Workers' Compensation Board. *Rehabilitation Services and Claims Manual*. Richmond, British Columbia: Workers' Compensation Board.

Brown, C. and E.C. Seto. 1988. *No-fault Automobile Liability Insurance in Canada*. Toronto: Carswell.

Brewer, G.D. and P. deLeon. 1983. *The Foundations of Policy Analysis*. Homewood, Illinois: The Dorsey Press.

Brunner, R.D. 1991. "The policy movement as a policy problem." *Policy Sciences* 24:65-98.

Calabresi, G. and A. D. Melamed. 1972. "Property rules, liability rules, and inalienability: one view of the cathedral." *Harvard Law Review* 85:1089-1128.

Cane, P. 1987. *Atiyah's Accidents, Compensation and the Law*. 4th ed. London: Weidenfeld and Nicolson.

Castle, E.N., R.P. Berrens and R.M. Adams. 1994. "Natural resource damage assessment: speculations about a missing perspective." *Land Economics* 70(3):378-385.

Cummings, R., D. Brookshire and W. Schulze. (eds.) 1986. *Valuing Environmental Goods*. Totowa, New Jersey: Rowman and Allenheld.

Cummings, R., G.W. Harrison and E.E. Rutstrom. 1995. "Homegrown values and hypothetical surveys: is the dichotomous choice approach incentive-compatible." *American Economic Review* 85(1):260-266.

David, H.A. 1988. *The Method of Paired Comparisons*. Alan Stuart (ed.) London: Charles Griffen & Company Limited.

de Groot, R.S. 1992. *Functions of Nature: Evaluation of Nature in Environmental Planning, Management and Decision Making*. Groningen: Wolters-Noordhoff.

Desvouges, W.H., F.R. Johnson, R.W. Dunford, K.J. Boyle, S.P. Hudson and K.N. Wilson. 1993. "Measuring natural resource damages with contingent valuation: tests of validity and reliability." In J.A. Hausman. (ed.) *Contingent Valuation: A Critical Assessment..* New York: North-Holland.

Diamond, P.A., J.A. Hausman, G.K. Leonard and M.A. Denning. 1993. "Does contingent valuation measure preferences?: experimental evidence." In J.A. Hausman. (ed.) 1993. *Contingent Valuation: A Critical Assessment*. New York: North-Holland.

Diamond, P.A. and J.A. Hausman. 1994. "Contingent valuation: is some number better than no number?" *Journal of Economic Perspectives* 8(4):45-64.

Dunn-Rankin, P. 1965. "The true distribution of the range of rank totals and its application to psychological scaling." Unpublished doctoral dissertation. Florida State University. Tallahasee. Cited in Dunn-Rankin. P. 1983. *Scaling Methods*. Hillsdale. New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Dunn-Rankin. P. 1983. *Scaling Methods*. Hillsdale. New Jersey: Lawrence Erlbaum Associates, Inc.. Publishers.

Dunn-Rankin, P. and F.J. King. 1969. "Multiple comparisons in a simplified rank method of scaling." *Educational and Psychological Measurement*, Summer 1969. 29(2):315-329. Cited in Dunn-Rankin, P. 1983. *Scaling Methods*. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Edwards, W. and D. von Winterfeldt. 1987. "Public values in risk debates." *Risk Analysis* 7(2):141-158.

Fleming. J.G. 1988. *The American Tort Process*. Oxford: Clarendon Press.

Fleming, J.G. 1992. *The Law of Torts*. 8th ed. Sydney, Australia: The Law Book Company Limited.

Florida. "Pollutant Discharge Prevention and Control Act." *Laws of Florida*. Ch. 92-113. s. 376.031 et seq.

81

Geselbracht, L. and R. Logan. Undated. "Washington's marine oil spill compensation schedule: simplified resource damage assessment." Unpublished paper. Washington State Department of Ecology. Olympia, Washington.

Grigalunas, T.A. and J.J. Opaluch. 1988. "Assessing liability for damages under CERCLA: a new approach for providing incentives for pollution avoidance?" *Natural Resources Journal* 28:509-533.

Guilford, J. P. 1954. *Psychometric Methods*. 2nd ed. H.F. Harlow. (ed.) New York: McGraw-Hill Book Company Inc.

Halter, F. and J.T. Thomas. 1982. "Recovery of damages by states for fish and wildlife losses caused by pollution." *Ecology Law Quarterly* 10:5-35.

Hardin, Garret. 1968. "The tragedy of the commons." *Science* 162(13):1243-1248.

Hausman, J.A. (ed.) 1993. *Contingent Valuation: A Critical Assessment*. New York: North-Holland.

Kahneman, D. and J.L. Knetsch. 1992a. "Valuing public goods: the purchase of moral satisfaction." *Journal of Environmental Economics and Management* 22:57-70.

Kahneman, D. and J.L. Knetsch. 1992b. "Contingent valuation and the value of public goods: reply." *Journal of Environmental Economics and Management* 22:90-94.

Kahneman, D., J.L. Knetsch and R.H. Thaler. 1990. "Experimental tests of the endowment effect and the Coase Theorem." *Journal of Political Economy* 98:1325-1348.

Kahneman, D., J.L. Knetsch and R.H. Thaler. 1991. "The endowment effect, loss aversion and status quo bias." *Journal of Economic Perspectives* 5:193-206.

Kahneman, D. and I. Ritov. 1994. "Determinants of stated willingness to pay for public goods: a study in the headline method." *Journal of Risk and Uncertainty* 9:5-38.

Kahneman, D. and A. Tversky. 1979. "Prospect theory: an analysis of decisions under risk." *Econometrica* 47:263-291.

Kealy, M.J. and R.W. Turner. 1993. "A test of the equality of close ended and open ended contingent valuations." *American Journal of Agricultural Economics* 75:321-331.

Kellert, S.R. 1983. "American attitudes toward and knowledge of animals: an update." *Int. J. Stud. Anim. Prob.* 1:87-119.

Kellert, S.R. 1984a. "Urban American perceptions of animals and the natural environment." *Urban Ecology*. 8:209-228.

Kellert, S.R. 1984b. "Assessing wildlife and environmental values in cost-benefit analysis." *Journal of Environmental Management* 18:355-363.

Kellert, S.R. 1993. "The biological basis for human values of nature." In S.R. Kellert and E.O. Wilson (eds.) *The Biophilia Hypothesis*. Washington, D.C.: Island Press.

Kellert, S.R. and E.O. Wilson (eds.) 1993. *The Biophilia Hypothesis*. Washington, D.C.: Island Press.

Kennedy, D. 1976. "Form and substance in private law adjudication." *Harvard Law Review* 89:1685-1778.

King, J.Y. 1987. *No-Fault Automobile Accident Law*. New York: John Wiley & Sons.

Knetsch, J.L. 1964. "The influence of reservoir projects on land values." *Journal of Farm Economics* 46(1):231-243.

Knetsch, J.L. 1994a. "Asking the right question: the reference point and measures of welfare change." Unpublished paper presented at the 69th Annual Conference of the Western Economic Association International. Vancouver, B.C.

Knetsch, J.L. 1994b. "Environmental valuation: some problems of wrong questions and misleading answers." *Environmental Values* 3:351-368.

Knetsch, J.L. 1995a. "Assumptions, behavioral findings, and policy analysis." *Journal of Policy Analysis and Management* 14(1):68-78.

Knetsch, J.L. and J.A. Sinden. 1984. "Willingness to pay and compensation demanded: experimental evidence of an unexpected disparity in measures of value." *The Quarterly Journal of Economics* 99:507-521.

Kopp, R.J. and V.K.Smith. (eds.) 1993a. *Valuing Natural Assets: The Economics of Natural Resource Damage Assessment*. Washington, D.C.: Resources for the Future.

Lasswell, H.D. 1971. *A Pre-View of Policy Sciences*. New York: American Elsevier Publishing Company, Inc.

Levin, F.S. 1989. "Pain and suffering guidelines: a cure for damages assessment 'anomie.'" *University of Michigan Journal of Law Reform* 22:303.

Logan, R. 1994. Personal interview. Washington State Department of Ecology. Olympia, Washington.

Maranall, G.M. (ed.) 1974. *Scaling: A Sourcebook for Behavioral Scientists*. New York: Aldine Publishing Company.

McManus, R.J. 1994. "Why the Ohio case shouldn't matter." *Natural Resources Journal* 34:109-120.

Mill, J.S. 1848. *Principles of Political Economy*. Books IV and V. Published 1985. Middlesex: Penguin Classics.

Mosteller, F. 1958. "The mystery of the missing corpus." *Psychometrika* 23(4). Cited in Dunn-Rankin, P. 1983. *Scaling Methods*. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Musgrave, R.S. and M.A. Stein. 1993. *State Wildlife Laws Handbook*. Rockville, Maryland: Government Institutes, inc.

New York State. 1994. "An Act to amend the environmental conservation law and the state finance law, in relation to enacting the 'Pollutant Discharge Prevention & Control Act of 1994.'" New York State. A10023.

New Zealand. "Accident Compensation Act." *The Statutes of New Zealand*. 1972. No. 43.

Pearce, D.W. and R.K. Turner. 1990. *Economics of Natural Resources and the Environment*. Baltimore: John Hopkins University Press.

*Peterson, G.L., T.C. Brown, D.W. McCollum, P.A. Bell, A.A. Berjulin, and A. Clarke. 1994. "Estimation of willingness to accept compensation for public and private goods from the chooser reference point by the method of paired comparison." Unpublished paper presented at ?W-133 in Tucson 2/94?

Pildes, R.H. 1992. "Conceptions of value in legal thought." *Michigan Law Review* 9:1520-1559.

Pildes, R.H. and E.S. Anderson. 1990. "Slinging arrows at democracy: social choice theory, value pluralism, and democratic politics." *Columbia Law Review* 90:2121-2214.

Pildes, R.H. and C.R. Sunstein. 1995. "Reinventing the regulatory state." *The University of Chicago Law Review* 62(1):1-129.

*Plante, K.J., E.L. Barnett, D.J. Preble and L.M. Price. 1993. "Florida's Pollutant Discharge Natural Resource Damage Assessment Compensation Schedule - a rational approach to the recovery of natural resource damages." Unpublished paper.

Radin, M.J. 1993. "Compensation and commensurability." *Duke Law Journal* 43:56-86.

Raz, J. 1986. *The Morality of Freedom*. Oxford: Clarendon Press.

Randall, A. 1987. *Resource Economics*. 2nd ed. New York: Wiley and Sons.

Regan, D.H. 1989. "Authority and value: reflections on Raz's Morality of Freedom." *Southern California Law Review* 9:1520-1559.

Rhoads, S.E. 1985. *The Economist's View of the World*. Cambridge: Cambridge University Press.

Ross, Robert T. 1939. "Optimal orders in the method of paired comparisons." *Journal of Experimental Psychology* 25:414-424.

Rummel, R.J. 1964. *An Introduction to Research Procedures in Education*. New York: Harper & Row. Cited in Dunn-Rankin, P. 1983. *Scaling Methods*. Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Schulze, 1993. "Use of direct methods for valuing natural resource damages." In R.J. Kopp and V.K. Smith. (eds.) *Valuing Natural Assets: The Economics of Natural Resource Damage Assessment*. Washington, D.C.: Resources for the Future.

Slovic, P. 1987. "Perceptions of risk." *Science* 236:280-285.

Sturgis, 1985. "The Cost of the U.S. Tort System." Tillinghast. Cited in Fleming, J.G. 1988. *The American Tort Process*. Oxford: Clarendon Press. At p. 1.

Sunstein, C.R. 1993. "Endogenous preferences, environmental law." *Journal of Legal Studies* 12:217-254.

Sunstein, C.R. 1994. "Incommensurability and valuation in law." *Michigan Law Review* 92(4):779-861.

Thaler, R. 1991a. "Mental accounting and consumer choice." In Thaler (ed.) *Quasi-rational Economics*. New York: Russell Sage Foundation. p.25.

Thaler, R. (ed.) 1991b. *Quasi-rational Economics*. New York: Russell Sage Foundation.

Thurstone, L.L. 1927. "A law of comparative judgment." *Psychological Review* 34:273-286.

Tversky, A. 1969. *Check Reference??*

United States (a). "Clean Water Act. 33 U.S.C. s. 1321 et seq.

United States (b) "Comprehensive Environmental Response, Compensation and Liability Act of 1980." 42 U.S.C. s. 9601 et seq.

United States (c). Oil Pollution Act of 1990. 33 U.S.C. s. 2701 et seq.

United States. 1994a. Department of Commerce, National Oceanic and Atmospheric Administration, Office of the General Counsel, Damage Assessment Regulations Team. "Compensation Formula for Natural Resource Damage Assessments under OPA: Oil Spills into Estuarine and Marine Environments." Washington, D.C.: United States Department of Commerce, National Oceanic and Atmospheric Administration.

United States. 1994b. Department of Commerce, National Oceanic and Atmospheric Administration. "Natural Resource Damage Assessments: Notice of proposed rulemaking." F.R. 59(5):1062-1189.

United States. 1994c. Department of Commerce, National Oceanic and Atmospheric Administration, Office of the General Counsel, Damage Assessment Regulations Team.

"Overview of the Process." Washington, D.C.: United States Department of Commerce, National Oceanic and Atmospheric Administration.

United States. 1995. Department of Commerce, National Oceanic and Atmospheric Administration. "Natural Resource Damage Assessments: Notice of proposed rulemaking." F.R. 60(149):39803-39834.

Usher, M.B. 1986. *Wildlife Conservation Evaluation*. London: Chapman and Hall.

Vatn, A. and D.W. Bromley. 1994. "Choices without prices without apologies." *Journal of Environmental Economics and Management* 26:129-148.

Waddams, S.M. 1991. *The Law of Damages*. 2nd ed. Toronto: Canada Law Book Limited.

Warner, R. 1992. "Incommensurability as a jurisprudential puzzle." *Chicago-Kent Law Review* 68:147-170.

Washington State. "Preassessment Screening and Oil Spill Compensation Schedule Rule." *Washington Administrative Code*. Ch. 173-183.

Websters Third International Dictionary of the English Language. 1986. Springfield, Massachusetts: Merriam-Webster Inc., Publishers.

Welsh, M., R. Bishop, G. Brown and E. MacDonald. 1993. "Fish and Wildlife Economic Model and Data." Volume II in United States. 1994. Department of Commerce, National Oceanic and Atmospheric Administration, Office of the General Counsel, Damage Assessment Regulations Team. "Compensation Formula for Natural Resource Damage Assessments under OPA: Oil Spills into Estuarine and Marine Environments." Washington, D.C.: United States Department of Commerce, National Oceanic and Atmospheric Administration.

Wilkinson, C.F. 1992. *Crossing the Next Meridian: Land, Water, and the Future of the West*. Covelo, California: Island Press.

Cases Cited

Andrews v. Grand & Toy [1978] 2 S.C.R. 229, 83 D.L.R. (3d) 452.

Arnold v. Teno [1978] 2 S.C.R. 287, 83 D.L.R. (3d) 609.

Colorado v. U.S. Department of the Interior, 880 F. 2d 481 (D.C. Cir. 1989).

Ohio v. United States Department of Interior, 880 F.2d 432, 459 (D.C. Cir. 1989).

Thornton v. Prince George School Board [1978] 2 S.C.R. 267, 83 D.L.R. (3d) 480.

Assessing Environmental Losses: Judgments of Importance and Damage Schedules*

Murray B. Rutherford,[#] Jack L. Knetsch,[##] and Thomas C. Brown[###]

INTRODUCTION

The growing recognition of environmental values and the consequent demands to take such values into account in public resource allocation decisions and assessments of damages have prompted extensive efforts to develop accurate monetary measures of value.[1] However, though a very limited range of environmental values can now be assessed with some degree of confidence, the research of the past four decades has not provided methods to reliably measure the economic values of most of the non-pecuniary environmental assets—those that do not have observable market prices—involved in damage claims and allocation decisions. Current valuations are, for the most part, limited in scope and accuracy and, in addition to being expensive, may well also be misleading.

The limitations of existing valuation methods have been particularly apparent in assessments of environmental damages. U.S. statutory requirements that those who cause environmental harms must pay compensation,[2] for example, have resulted in expensive and

---

[#] (LL.B. University of British Columbia, M.R.M. Simon Fraser University) Ph.D. Student, Yale University

[##] (Ph.D. Harvard) Professor, Simon Fraser University

[###] (Ph.D. University of Arizona) Economist, U.S. Forest Service

[1] For example, A. Vatn & D.W. Bromley (*Choices Without Prices Without Apologies*, 26 J. OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT 129, 129 (1994)) report that during the period from 1990 through 1993, approximately one-third of the articles in two prominent resource economics journals (LAND ECONOMICS and the JOURNAL OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT) were devoted to valuation.

[2] *See, e.g.*, Comprehensive Environmental Response, Compensation and Liability Act (hereinafter CERCLA), 42 U.S.C., § 9607(a)(4)(C) (1996); Oil Pollution Act (hereinafter OPA), 33 U.S.C., § 2702(b)(2)(A) (1996).

contentious assessments that, while often giving the illusion of precision, are widely regarded as providing only the roughest approximation of actual values, and may well provide more of an index of concern rather than the sought after monetary values that are comparable to those derived from market exchange.[3] It is unrealistic to expect that damage assessments based on such estimates will efficiently achieve the deterrence and restitution objectives for which they are intended.

The disappointing performance of most current post-incident economic valuation methods has stimulated interest in alternative means of assessing, or otherwise dealing with, environmental losses.[4] For example, Heyde suggests that, in view of the inadequacies of the most prominent current measurement technique (the contingent valuation method), a rule of thumb be used instead that could be based on one of three possibilities: (i) the cost of restoring the resource; (ii) some multiple of the damages that can be measured; or (iii) a fixed schedule of loss values.[5] It is this third possibility that we explore in this paper.

The suggestion that environmental damages be assessed on the basis of a fixed schedule is not a new idea, as demonstrated by the fact that several U.S. states have already implemented schedules of compensation for some types of environmental losses. For example, in Washington

---

[3] *See* D. Kahneman, & I. Ritov, *Determinants of Stated Willingness to Pay for Public Goods: A Study in the Headline Method*, 9 J. RISK AND UNCERTAINTY 5 (1994). The lack of comparability of contingent valuation responses to market prices is a particular concern in numerous cases involving conflicting uses of resources in which the value of one use is based on market prices and the other is based on such hypothetical assessments (for example, the use of old growth forest as timber compared to its use as wilderness).

[4] The cost and perceived inadequacy of ad hoc value assessment have been the main incentives for change (*see* T.A. Geselbracht & J.J. Logan, Washington's Marine Oil Spill Compensation Schedule: Simplified Resource Damage Assessment (n.d.) (unpublished manuscript, Washington State Department of Ecology, Olympia). The 1985 Arco Anchorage crude oil spill in Washington State is a striking example—the environmental assessment cost $245,000, but damages were assessed at only $32,930. *See* T.A. Grigalunas & J.J. Opaluch, *Assessing Liability for Damages Under CERCLA: A New Approach for Providing Incentives for Pollution Avoidance?*, 28 NATURAL RESOURCES J. 509, 512 (1988). Moreover, it cannot be asserted with confidence that the values were accurately assessed, or that the damages charged provide any real guidance to the actions of others.

[5] J.M. Heyde, *Is Contingent Valuation Worth the Trouble?*, 62 U. CHI. L. REV. 331 (1995).

State damages arising from small spills of oil or other hazardous substances are assessed under an administratively prescribed damage schedule, in which compensation awards are specified in advance, and vary with the size of spill, the type of substance spilled, and the geographic location of the damage.[6] Similar schedules have been adopted in other jurisdictions in the United States, although in each case their use is limited to assessing relatively minor damages caused by small spills. Proponents claim that, although somewhat arbitrary, these "environmental damage schedules" can produce simplified, less expensive, more predictable, and more enforceable calculations of compensation amounts than is possible with post-incident valuations.[7]

Damage schedules provide predictability and enforceability by specifying *in advance* the payments that will be required in the event of a loss, rather than waiting until the damage has taken place. Thus, the large transaction costs associated with the typical post-incident assessment are minimized, and the knowledge of the consequences provides a greater deterrence incentive for the actions of others. Plante et al.[8] compare such environmental damage schedules to liquidated damages clauses, which are used occasionally in commercial contracts to establish in advance the damage payments that will be required in the event of a breach. For environmental damage

---

[6] Preassessment Screening and Oil Spill Compensation Schedule Rule, WASH. ADMIN. CODE. § 173-183 (1992).

[7] *See, e.g.*, K.J. Plante, E.L. Barnett, D.J. Preble & L.M. Price, Florida's Pollutant Discharge Natural Resource Damage Assessment Compensation Schedule - A Rational Approach to the Recovery of Natural Resource Damages, (1993) (unpublished manuscript, State of Florida Department of Natural Resources, Tallahassee); Geselbracht & Logan, *supra* note 4.

[8] *Supra* note 7, at 718.

schedules, as for contractual liquidated damages clauses, the need for an ex ante specification arises in part because it is difficult or expensive to determine the actual value of the losses.[9]

Accurate—or even rough, if consistent and reliable—post-incident valuations would be preferable to the use of such damage schedules, but for most environmental losses such valuations are currently not a realistic option. Damage schedules offer a possibly attractive alternative, at least on an interim basis, that may provide many if not most of the advantages of valuation, with perhaps minimal sacrifice.

Damage schedules can reflect citizens' judgments of the relative importance of different losses, without the necessity of direct monetary valuation. While people appear to be unable to provide consistent monetary measures of environmental losses, they may well be able to provide the far less demanding indications of the relative importance of different losses. To the extent that people can rank or rate the relative importance of different environmental changes, this can provide empirical support for the design of allocation policies and assessments of damage claims that reflect community values—a basis that can yield a better mirror of social objectives than the current monetary valuations, negotiations between policy makers and interested parties, or the often even more arbitrary and inconsistent "resolutions" imposed by fiat or by tribunals. The use

---

[9] There are other similarities between damage schedules and commercial contracts:

> Inherent in the relationship between the state, as trustees over the natural resource through and over which commercial shipping occurs, and ship owners and vessel masters is an implied contract. In return for the consideration of the ability to ply the state's waters, ship owners agree to conduct their activities in such a manner as to minimize the impact on the environment, and, in the event that such activities damage the state's natural resources, to offer reasonable compensation.

Plante et al., *supra* note 7, at 718.

of such schedules, based on empirical assessments of relative importance, might well go a considerable way towards achieving the purposes for which valuations are desired.[10]

Assessments of the relative importance of different adverse environmental outcomes or events—for example, the death of a certain number of sea birds resulting from an oil spill or the loss of a particular area of moose habitat—can be obtained from a series of pair-wise comparisons, in which each outcome is compared to each other outcome and a choice is made based on relative importance. The aggregate results of such choices made by a group of respondents can be arranged on a scale of relative importance, an "importance scale," and related to characteristics (such as physical and biological characteristics) found empirically to have significant impacts on assessments of the relative importance of each occurrence. These determinants of relative importance might include qualitative and quantitative descriptions of different losses, or "consequences" (such as the death of fifty marine birds of a particular species, or the loss of one hundred sea otters), and characteristics of the environmental "occurrences" that cause losses (such as an oil spill, or a landslide caused by logging road construction). The scale value assigned to each loss would represent the scaled relative importance of a particular

---

[10] Although our focus here is on environmental losses and damage schedules, we also consider the potential usefulness of rankings of the relative importance of environmental changes (gains as well as losses) in broader policy making contexts. The choice of the appropriate measure for valuing a given change in environmental circumstances—whether a negative change should be assessed as a loss or as a foregone gain, and whether a positive change is best regarded as a gain or as a reduction of a loss—is an important issue in itself. *See* J.L. Knetsch, *Reference States, Fairness, and Choice of Measure to Value Environmental Changes, in* PSYCHOLOGICAL PERSPECTIVES TO ENVIRONMENTAL AND ETHICAL ISSUES IN MANAGEMENT (M. Bazerman, D. Messick, A. Tenbrunsel and K. Wade-Bensoni eds., Jossey-Bass, in press). As the magnitude of the value associated with a given change may vary dramatically depending on whether the change is characterized as a gain rather than a reduction of a loss in the case of an improvement, or is seen as a loss or a foregone gain in the case of a deterioration (see the discussion of this issue in Section II, infra), the choice of the correct characterization is crucial. Empirical evidence indicates that the correct measure of value depends on the "reference point" from which the environmental change is evaluated. Most environmental changes are currently assessed as if they were gains (for example, contingent valuation questions designed to assess environmental damage after it has occurred will often ask questions such as, "What would you be willing to pay to prevent X from occurring?"—thereby categorizing the change as a gain, or benefit, from the existing damaged state). However, the appropriate reference point is the situation that is considered by the valuer to be the normal or expected state, and for many changes affecting environmental assets this reference will be the "natural" or "undamaged" state of affairs, strongly implying that the change should be evaluated as a loss or as a reduction or avoidance of a loss. Thus, our focus here on losses.

combination of characteristics. Initial scale values of only a few selected "typical" environmental losses could be expanded over time by including other losses of differing form or magnitude as they are encountered, by interpolating or extrapolating from those previously scaled, so that an increasingly comprehensive profile of relative importance gradually evolves. Although such an importance scale would not provide an assessment of economic values, the scale could be used to structure the remedies prescribed in an "interim" damage schedule,[11] by assigning to each environmental harm a dollar amount or other remedy appropriate to its importance in comparison with other harms.

In order to explore the potential for this approach to damage assessment and allocation decisions, we first review in Section I the roles that accurately assessed values are generally thought to play in policy and decision making. In Section II we discuss why it is so difficult to produce accurate assessments of the values of non-pecuniary environmental assets. Section III looks at some existing or proposed schedules of compensation for non-pecuniary losses, to show how these initiatives have been developed in practice. Section IV reports the results of an empirical demonstration of individuals' judgments of the relative importance of non-pecuniary environmental losses, and illustrates a simple method of aggregating and interval-scaling their preference responses. Section V explains how such preference data could be used to construct an interim damage schedule. Finally, the Conclusion discusses how well the resulting scale and schedule could serve the policy objectives for which accurately assessed values are generally thought to be required.

---

[11] The term "interim" is used to suggest that the schedule would be adjusted with developing valuation information and changing circumstances (and to mitigate more adverse reactions that commonly accompany proposals implying more permanent arrangements—as with long-term loans usually being more acceptable than transfers of entitlement; see B. Frey, & W. Pommerehne, *International Trade in Art: Attitudes and Behavior*, 34 RIVISTA INTERNAXIONALE DI SCIENZE ECONOMICHE A COMMERCIALI 465 (1987)).

I. Environmental Values: Efficiency and Other Goals

Market prices provide useful measures of the economic value of market goods and services, and supply important incentives to buyers and sellers to use resources consistent with these values. The environmental goods at issue here, however, do not trade in markets, for various reasons having to do with market failures—externalities, common property problems— and community rejection of market outcomes on grounds, for example, of inequitable distribution of environmental amenities. Consequently, the values of these goods are not revealed in market prices. Non-pecuniary environmental assets are no less economically valuable than goods traded in markets, as people are clearly willing to sacrifice other goods and services—the definition of economic worth—in order to acquire, maintain, or preserve them, or pass them on to others. But the value of any loss or gain of such assets must be expressed in other, non-market ways.[12]

This absence of ready and conspicuous monetary measures of environmental values, and the propensity therefore to treat them as having no economic worth, gives rise to problems in at least three areas related to the efficient use of resources: (i) allocating public resources in ways that are consistent with their importance to the community; (ii) providing appropriate incentives to individuals who use or may harm the resources; and (iii) assessing damages when environmental resources are harmed or degraded by an unexpected event, such as an oil spill, or an intentional activity, such as waste discharge.

To the extent that environmental values are more accurately assessed, they will presumably be more appropriately weighed in public and private resource allocation decisions. For

---

[12] The value of environmental assets is commonly separated into "use" value and "non-use," or "passive-use" value. Although exact classifications vary, it is generally agreed that the main component of use value is the value arising from direct use of an environmental asset. This includes consumptive activities, such as fishing and hunting, as well as activities normally considered to be non-consumptive, such as bird-watching. Some analysts also classify "option" value (the value attributable to preserving the option of having an environmental asset available for use in the future) as a use value. Others classify option value as a passive-use or non-use value, because it does not involve current use by the valuing individual. Passive-use or non-use value generally includes all value that does not involve direct use of an environmental asset, including value attributable to the mere knowledge of the existence of the asset ("existence value"). Passive or non-use value, which may be very large for some assets, poses the greatest difficulty for quantitatively assessing damages to the environment.

example, if the non-market values of wilderness areas were known, policies could be better designed to protect the socially optimum amount of wilderness, without overly restricting other uses of such natural resources. Similarly, just as waste and over-use are encouraged when non-priced resources are treated as having no value, requiring payment that more appropriately reflects social values provides incentives to use such resources at more socially desirable levels. Such value-based prices also reduce uncertainty in determining permissible use levels, and reduce transaction costs as consumers and producers adjust automatically to the announced prices. This allows more efficient planning of public and private activities. Also, in the case of environmental losses, as the costs become more predictable, liability insurance becomes more readily available at lower rates.[13]

The absence of ready measures of values has also created difficulties for environmental damage assessment. There are, however, a variety of possible policy objectives underlying the practice of requiring compensation payments from those who harm the environment, and the importance of accurate monetary valuation of non-pecuniary harms may vary depending on the social purpose that the award of damages is expected to serve.

Castle et al. identify three reasons for requiring those who harm the environment to pay damages: (i) to permit individual losers to be compensated; (ii) to pay for environmental restoration; and (iii) to deter future accidents.[14] Each of these can be attributed to a desire to

---

[13] The present scarcity of environmental insurance may be attributable in part to the uncertainty of environmental damage awards—it is almost impossible to predict the magnitude of potential losses. To some extent, this may be due to uncertainty about the probability and magnitude of harm, rather than uncertainty about the amount of damages that will be awarded. But as many potentially harmful activities have long experience records, actuaries may often be able to make reasonable predictions of the probabilities of losses of various magnitudes occurring. The less predictable process of assigning dollar values to the losses may be more problematic. This issue has perhaps not been given adequate consideration in environmental policy making, when compared with the emphasis given to expanding liability. Expanded liability is of limited use if judgments are not recoverable and if individuals have little predictability of outcomes and consequences.

[14] E.N. Castle, R.P. Berrens & R.M. Adams, *Natural Resource Damage Assessment: Speculations About A Missing Perspective*, 70 LAND ECON. 378 (1994).

internalize externalities—to ensure that all of the costs of an action are borne by the parties responsible for bringing those costs about. The standard economic analysis indicates that if the costs are properly measured in terms of full social value and are charged to those responsible, then the amount that those individuals will expend to avoid or minimize environmental damage will equal the value that society places on avoiding the environmental loss.[15]

Compensation payments for non-pecuniary harms can, however, serve other social purposes. These have been more extensively analyzed in connection with personal injury losses, where non-pecuniary damages are well recognized.[16] Radin, for example, recognizes "corrective justice" as an objective of compensation payments for non-pecuniary personal injuries:

> [T]o make required changes in an unjustified state of affairs between an injurer and a victim, when the injurer's activity has caused the injustice, so that such changes bring about a just state of affairs between them, and one that is related in a morally appropriate way to the status quo ante. A shorthand way of saying this is that corrective justice restores moral balance between the parties.[17]

Moral balance may be achieved by restoring the parties to their original circumstances prior to the incident (restitution), or by restoring the parties to a situation that is morally equivalent to those

---

[15] Castle et al., *supra* note 14, go on to question whether accurately measured environmental values are needed to achieve the deterrence functions commonly attributed to environmental damages, and whether damages really act as deterrents in this context in any event.

[16] The similarity between compensation for non-pecuniary environmental harms and compensation for non-pecuniary personal injuries has been noted elsewhere. *See, e.g.,* K.K. Baker *Consorting with Forests: Rethinking Our Relationship to Natural Resources and How We Should Value Their Loss*, 22 Ecology L.Q. 677, 697 (1995) (suggesting that tort law—specifically the doctrines of dignitary torts, nominal damages and pain and suffering—rather than property law, provides the proper parallel for the kind of loss that is suffered when the natural environment is damaged); J.C. Dobbins *The Pain and Suffering of Environmental Loss: Using Contingent Valuation to Estimate Nonuse Damages*, 43 Duke L.J. 879 (1994) (arguing that the broad legal acceptance of damage recovery for pain and suffering losses in tort law is a justification for allowing recovery of non-pecuniary environmental damages).

[17] M.J. Radin, *Compensation and Commensurability*, 43 Duke L. J. 56, 60 (1993).

circumstances (rectification, which can include restitution).[18] Moral balance may also be restored by redress:

> Requiring payment is a way both to bring the wrongdoer to recognize that she has done wrong and to make redress to the victim. Redress is not restitution or rectification. Redress instead means showing the victim that her rights are taken seriously. It is accomplished by affirming that some action is required to symbolize public respect for the existence of certain rights and public recognition of the transgressor's fault in disrespecting those rights. In this conception of compensation, neither the harm to the victim nor the victim's right not to be harmed are commensurate with money. They are not conceptually equated with fungible commodities.[19]

Thus, to make redress may not require assessment of an exact monetary value for a loss.

Another possible justification for paying compensation to those who suffer non-pecuniary harms is to provide solace to the injured party:

> Since it is almost impossible in any modern legal system to award compensation in any form other than money, it follows that giving compensation for 'losses' which cannot be replaced by money (such as pain and suffering or loss of amenity) must have a different purpose from that involved in giving compensation for things that can be replaced by money. The object here cannot be to replace what has been lost by some equivalent, but to enable the victim to obtain a substitute source of satisfaction or pleasure, or alternatively to comfort him (provide him with solace) for what has happened.[20]

As with redress, then, solace may not require accurate monetary assessment of values, because it does not require a payment that is equal to the exact value of the loss. Indeed, the Supreme Court of Canada has used this lack of accuracy, or of need for accuracy, as one justification for imposing an overall cap on damages for pain and suffering in personal injury cases: "The sheer

---

[18] *Id.*

[19] *Id.*, at 61.

[20] P. CANE, ATIYAH'S ACCIDENTS, COMPENSATION AND THE LAW 474 (4th ed. 1987).

fact is that there is no objective yardstick for translating non-pecuniary losses, such as pain and suffering and loss of amenities, into monetary terms."[21]

II. MEASURING VALUES OF NON-PECUNIARY ENVIRONMENTAL ASSETS

Three major issues complicate the measurement of non-pecuniary environmental values: (i) the appropriate measure of value; (ii) the limitations of existing economic measurement techniques; and (iii) the possibility of incommensurable values.

A. The Appropriate Measure of Value

The economic value of a gain or a loss, including the enhancement or degradation of an environmental asset or amenity, is what people are willing to sacrifice. As Michelman states, the economic measures of gains and losses are determined from distinct perspectives: "Benefits are measured by the total number of dollars which prospective gainers would be willing to pay to secure adoption, and losses are measured by the total number of dollars which prospective losers would insist on as the price of agreeing to adoption."[22] The appropriate measure of an environmental loss is, therefore, not the maximum amount people would be willing to pay (WTP) to prevent it, but is instead the minimum compensation that individuals would require to accept it (the willingness to accept, or WTA).

Although minimum compensation, or WTA, is the agreed appropriate economic measure of losses, assessments of environmental losses are in practice nearly universally made in terms of people's maximum willingness to pay to avoid such losses—the WTP measure. The United States

---

[21] Andrews v. Grand & Toy, [1978] 2 S.C.R. 229, 261; *and see* Thornton v. Prince George School Board, [1978] 2 S.C.R. 267; Arnold v. Teno, [1978] 2 S.C.R. 287. The cap was initially set at $100,000 (Canadian), and is adjusted with inflation.

[22] F.I. Michelman, *Property, Utility, and Fairness: Comments on the Ethical Foundation of Just Compensation Law*, 80 HARV. L. REV. 1165, 1214 (1967).

National Oceanic and Atmospheric Administration (USNOAA) noted, for example, that in assessing damages of specific environmental losses "virtually all previous CV [contingent valuation] studies have described scenarios in which respondents are asked to pay to prevent future occurrences of similar accidents."[23]

A major reason for the continued use of the WTP measure to assess losses is the assertion of traditional economic theory that the valuations of gains and of losses are for all practical purposes fully equivalent—that "[a]ccording to utility theory, the amount subjects would be willing to pay to clean up a site should be the same as the compensation they would be willing to accept to allow someone to pollute the site (except for a minor income effect)."[24] The conventional assumption that the WTP and WTA measures lead to equivalent values, except for an agreed minor disparity due to income or wealth effects or constraints, is one of long and enduring standing. No exploration or accounting for any difference is in practice made or thought to be necessary because of the belief that "as a practical matter it usually does not make any difference which of these two . . . is adopted."[25] As a result, the allegedly more conveniently measured WTP has become the measure of choice for both environmental gains and losses.

Although the equivalence assertion continues to be used to justify present valuation practice, it has little empirical support. Instead, the empirical evidence overwhelmingly shows that

---

[23] Report of the NOAA Panel on Contingent Valuation, 58 Fed.Reg. 4601, 4603 (1993) [hereinafter USNOAA Panel Report].

[24] C.V. Philips & R.J. Zeckhauser, *Contingent Valuation of Damage to Natural Resources: How Accurate? How Appropriate?*, TOXICS LAW REPORTER, October 1989, at 520, 527.

[25] S.E. RHOADS, THE ECONOMIST'S VIEW OF THE WORLD, 125 (1985).

WTA significantly exceeds WTP for the identical good. This evidence has been mounting both in experimental settings[26] and in observations of every day human behavior.[27]

The findings of large disparities between valuations of gains and losses have now been reported by many investigators using a variety of methods to evaluate widely varied assets and

---

[26] The results of earlier survey studies and later more persuasive real exchange experiments have been reported in leading economics journals for over a decade and consistently show systematic and large valuation disparities between the two measures which are independent of transaction costs, repetition of trade offers, and income or wealth constraints. *See, e.g.,* J. HAMMACK & G. BROWN, WATERFOWL AND WETLANDS: TOWARD BIOECONOMIC ANALYSIS, (1974); J.L. Knetsch & J.A. Sinden, *Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value,* 99 QUARTERLY J. ECONOMICS 507 (1984); D. Kahneman, J.L. Knetsch & R.H. Thaler, *Experimental tests of the endowment effect and the Coase Theorem,* 98 J. POLITICAL ECONOMY 1325 (1990); R.R. Boyce, T.C. Brown, G.H. McClelland, G.L. Peterson & W.D. Schulze, *An experimental examination of intrinsic values as a source of the WTA-WTP disparity,* 82 AMER. ECON. REV. 1366 (1992); S.J. Kachelmeier & M. Shehata, *Examining Risk Preferences Under High Monetary Incentives: Experimental Evidence from the People's Republic of China,* 82 AMER. ECON. REV. 1120 (1992). Kachelmeier & Shehata, *supra,* for example, found that the same individuals would be willing to pay about half as much to acquire an entitlement to a fifty percent chance to win $20 as they would require to give up the same prospect. The compensation measures (WTA) are typically from two to five or more times larger than the payment measures (WTP) for what are otherwise the same entitlements. Although some studies suggest that repeated trials might lead to reductions in (or elimination of) the WTA/WTP disparity (*see* J.F. Shogren, S.Y. Shin, D.J. Hayes and J.B. Kliebenstein, *Resolving Differences in Willingness to Pay and Willingness to Accept,* 84 AMER. ECON. REV. 255 (1994)), further tests attribute the reductions observed in those studies to the use of the Vickery auction design, which may fail to accurately reveal peoples' valuations (*see* D. Kahneman, J.L. Knetsch & R.H. Thaler, The Endowment Effect and the Vickery Auction, (1995) (unpublished University of Chicago working paper)).

[27] Larger valuations of losses relative to gains in people's actual behavior in making real choices have been documented in a variety of cases. *See* D. Kahneman, J.L. Knetsch & R.H. Thaler, *The Endowment Effect, Loss Aversion and Status Quo Bias,* 5 J. ECON. PERSP., 193 (1991). Frey & Pommerehne, *supra* note 11, for example, note that collective endowment effects clearly motivate the asymmetric treatment accorded the acquisition and retention of national art treasures. The valuation disparity, and the consequent reluctance to sell at a loss, has also been evident in the greater volume of house sales when prices are rising and in the similar smaller volume of sales of securities that have declined in price relative to those for which prices have increased. *See* H. Shefrin & M. Statman, *The Disposition to Sell Winners Too Early and Ride Losers Too Long: Theory and Evidence,* 40 J. FINANCE 777 (1985). Consistent with these dealings, the magnitude of change in the prices of securities is greater after dividend payments are omitted than when such dividends are initiated. *See* R. Michaely, R.H. Thaler, & K.L. Womack, *Price Reactions to Dividend Initiations and Omissions: Overreaction or Drift?,* 50 J. FINANCE 573 (1995). There are typically greater demands for regulation of new risks than equivalent old risks, particularly including environmental risks. *See* C.R. Sunstein, *Endogenous Preferences, Environmental Law,* 12 J. LEGAL STUDIES 217 (1993). Further examples of differences in valuations of gains and losses are the observed strong reluctance to give up a default automobile insurance option when an attractive choice is readily available (*see* E.J. Johnson, J. Hershey, J. Meszaro, & Howard Kunreuther, *Framing, Probability Distortions, and Insurance Decisions,* 7 J. RISK AND UNCERTAINTY 35 (1993)); and the greater legal protection accorded losses over foregone gains in judicial choices (*see* D. Cohen, & J.L. Knetsch, *Judicial Choice and Disparities Between Measures of Economic Values,* 30(3) OSGOODE HALL L. J. 737 (1992)).

entitlements. The readings of this record suggest, "It is now well established that individuals value possible gains much differently than they value possible losses."[28]

A direct consequence of the continued practice of using WTP measures to assess environmental damages is that such losses will be consistently and greatly understated, leading to distortions of incentives, misallocation of resources, and undercompensation of losses.[29]

B. Limitations of Existing Economic Measurement Techniques

Methods used to estimate the values of non-pecuniary environmental assets rely either on indirect measures based on related market purchases or on direct survey responses to hypothetical questions. The techniques vary both in their applicability and in the validity of the resulting valuations.

1. Restoration cost

This measure is simply the cost of restoring an environmental asset which has been destroyed or damaged. It has several problems as a measure of value. First, restoration cost can only be estimated when it is possible to restore the damaged environmental asset, which may not be the case because of bio-physical limitations or insufficient knowledge. Second, restoration cost does not measure the value lost during the time when restoration is occurring—which, given the common reliance on long term natural processes that are a major part of many environmental restoration efforts, may be a substantial loss—nor does it take account of any remaining loss if the

---

[28] D.W. Bromley, *Property Rights and Natural Resource Damage Assessments*, 14 ECOLOGICAL ECON. 129, 133 (1995).

[29] J.L. Knetsch, *Environmental Policy Implications of Disparities Between Willingness To Pay and Compensation Demanded Measures of Values*, 18 J. ENVIRON. ECON. MANAGEMENT 227 (1990).

restoration is deemed to be less than a perfect substitute for the original.[30] Third, although it can be used to set damages, restoration cost is not a measure of value at all—indeed, the actual value of the loss may far exceed or fall short of the restoration cost.

2. Replacement cost

Replacement cost is the sum that would be required to provide a substitute that would yield an equivalent flow of goods and services. Like restoration cost, adopting replacement cost as a measure of the value of the damage avoids the necessity of actually measuring the environmental value at issue. Replacement cost has the additional advantage of considering substitutes in determining the cost of ameliorating the damaged situation. However, many environmental resources do not have close substitutes. Hatchery programs designed to rebuild salmon stocks on the west coast of Canada and in the Pacific Northwest of the United States provide an illustration. Although hatchery-bred fish were originally used as replacements for lost natural stocks, and would appear to provide a logical measure of the replacement value of damaged natural stocks, it has been found that hatchery fish lack the genetic diversity, disease resistance, and overall strength of wild fish.[31] Also, as with restoration cost, replacement cost

---

[30] Courts in the United States have identified the diminution of value pending recovery of an environmental asset as an important component of damage assessment, and as a component that is missing from measures of replacement or restoration cost. *See* Colorado v. U.S. Dep't. of the Interior, 880 F. 2d 481 (D.C. Cir. 1989). Theoretically, the value lost during the recovery period could be compensated by charging interest on the full final cost from the time of the loss until restoration or replacement is effected. However, determining the rate of interest that will exactly compensate for the loss may be as problematic as directly assessing the value lost during the recovery period.

[31] *See* C.F. WILKINSON, CROSSING THE NEXT MERIDIAN: LAND, WATER, AND THE FUTURE OF THE WEST 217-18 (1992); M. McGinnis, *On the Verge of Collapse: The Columbia River System, Wild Salmon and the Northwest Power Planning Council*, 35 NATURAL RESOURCES JOURNAL 63, 72-73. In addition, as gains seem to be valued differently from losses, "[P]eople's willingness to accept one resource gain as a substitute for the loss of another resource, may be more constrained than is usually presumed." J.L. Knetsch, *Environmental Valuation: Some Problems of Wrong Questions and Misleading Answers*, 3 ENVIRONMENTAL VALUES 351, 355 (1994). With respect to damage assessment, this implies that rectification (restoring the parties to a situation that is morally equivalent to their circumstances prior to the incident) may be possible only through full restoration of the damaged asset, or true replacement with an identical asset (in the rare cases where this is possible)—in other words, through restitution (restoring the parties to their original circumstances prior to the incident). If the funds paid as damages are not actually used to repair or replace the asset, restitution will not be achieved.

measures do not capture the value lost during the replacement period, nor is replacement cost an appropriate measure of damage when the value of the loss is less than the cost of providing the substitute.

3. Hedonic price method

The hedonic price method provides an estimate of a non-priced value by determining the extent to which it contributes to the price of a marketed asset. The value of a scenic view, for example, might be determined by the difference in prices of otherwise similar houses with and without such a view.

Although reasonably straightforward in terms of the necessary calculations, one difficulty is that in most applications only a value at the margin is provided. That is, as market prices form the basis of the estimate, it directly accounts for only individuals at the margin of buying or selling the priced asset, and does little to account for the possibly larger values of intra-marginal owners who may value the amenity well above its contribution to the price, because they regard other houses (for example) as imperfect substitutes for their own. Some rough adjustments can be made to take some account of these larger values, but these are usually much less precise.[32]

A far more important limitation of the method is that it cannot be used to assess very many environmental losses. For an environmental loss to be subject to valuation using the hedonic method, the loss must be common and persistent enough to affect the existing price of a market good. For example, persistent pollution levels that vary throughout a region may affect housing prices. Many environmental losses, however, are episodic, and others, even if common and persistent, do not directly affect the price of a market good.

4. Travel cost method

The travel cost method is another valuation technique that relies on observed market behavior to infer a non-pecuniary value, in this case the value of a site that people must travel to

---

[32] A.E. BOARDMAN, D.H. GREENBERG, A.R. VINING, & D.L. WEIMER, COST-BENEFIT ANALYSIS: CONCEPTS AND PRACTICE (1995).

in order to enjoy, such as a recreational facility. Based on the observed proportions of populations living at varying distances from a recreation area who are willing to incur their respective costs of traveling to and from the site, an estimate can be made of how many would be willing to pay various additional amounts to gain access to the recreation area.[33]

Problems in using the travel cost method include: (i) allocating joint costs of travel if the recreation site of interest was not the only destination of the trip; (ii) accounting for the value (or cost) of travel time in the estimate of travel cost; and (iii) choice of the most appropriate functional form for expressing the cost-visit rate relationship. However, as in the case of the hedonic price method, the greatest limitation is the method's severely restricted range of applicability. At best, the method yields an estimate of the use value of a facility or site. The method does not provide any indication of non-use value or of the values of environmental assets that are not attributable to people's incurring costs to gain proximity. The method also yields a WTP measure, not a WTA measure, and while it is therefore appropriate for valuing gains, it is not an appropriate means to assess damages or reductions in losses.

5. Contingent valuation method

By far the most common approach used to estimate the monetary value of environmental losses is the contingent valuation method (or CVM). Rather than rely on indirect inference from market choices, CVM assessments are derived directly from responses to questions asking people how much they would be willing to pay to acquire an entitlement or to prevent the loss of one. First demonstrated in 1963,[34] over two thousand CVM studies have now been recorded.

---

[33] M. CLAWSON, & J.L. KNETSCH, ECONOMICS OF OUTDOOR RECREATION (1966).

[34] R.K. Davis, The Value of Outdoor Recreation: An Economic Study of the Maine Woods (1963) (unpublished Ph.D. dissertation, Harvard University). It is worth noting that Davis's study was intended to assess the likely much more tractable use value of a resource, recreation, rather than the likely more ill-defined passive value of a resource, such as that due to its known existence or knowing that a far off shoreline is free of spilled oil.

17

Contingent valuation methods have been endorsed by court approvals, at least in the United States, and by a profusion of early favorable reports in professional journals. However the extent to which such survey responses can be taken as fully comparable to economic valuations stemming from voluntary market exchanges, as intended, is now subject to serious doubt, particularly for those goods with which people have the least amount of market experience, such as collectively owned nonpecuniary environmental services.

A major difficulty, acknowledged by nearly all, is that CVM surveys are least reliable when used to elicit how much compensation people would demand to agree to a loss—the WTA measure.[35] This necessitates that the method can only provide an inappropriate and greatly understated WTP measure of losses.

A further persistent worry, which has recently received increased attention, is that responses to hypothetical questions may not accurately reflect actual valuations of people. An example of the difference is the recent report of a median $30 average hypothetical willingness to pay for an antique map for which the median value people would actually pay was only $5.[36]

Another problem with CVM surveys is the demonstrated susceptibility of respondents to anchoring biases. The proportions of different groups of respondents who said, for example, that they would be willing to pay $50 to preserve particular fish populations varied from 18 per cent to

---

[35] *See* USNOAA Panel Report, *supra* note 23, at 4603.

[36] H. Neill, R. Cummings, P. Ganderton, G. Harrison, & T. McGuckin, *Hypothetical Surveys and Real Economic Commitments*, 70(2) LAND ECON. 145 (1994). Other studies reporting that contingent valuation over-estimates actual payments include: M.J. Kealy, J. Dovidio & M. Rockel, *Accuracy in Valuation is a Matter of Degree*, 64(2) LAND ECON. 158 (1988); Boyce et al., *supra* note 26; T.C. Brown, P.A. Champ, R.C. Bishop & D.W. McCollum, *Which Response Format Reveals the Truth About Donations to a Public Good?*, 72(2) LAND ECON. 152 (1996); J. Loomis, T. Brown, B. Lucero, & G. Peterson., *Improving Validity Experiments of Contingent Valuation Methods: Results to Reduce the Disparity of Hypothetical and Actual Willingness to Pay*, 72(4) LAND ECON. 450 (1996); and R. Cummings, G.W. Harrison & E.E. Rutstrom, *Homegrown Values and Hypothetical Surveys: Is the Dichotomous Choice Approach Incentive-Compatible*, 85(1) AMER. ECON. REV. 260 (1995). For example, Cummings et al., *supra*, found that 42 percent of respondents indicated a willingness to pay $3.50 for a box of chocolates, but only four percent actually paid when confronted with a real rather than hypothetical exchange.

63 per cent, depending entirely on their being asked to pay a higher or a lower sum immediately before being asked about paying $50.[37]

In response to such findings, many advocate the use of a dichotomous choice (yes/no) approach in which people are asked if they would or would not pay a single sum, with this amount varied among respondents. However, this too has been shown to have serious weaknesses in that the proportions willing to pay often do not vary much over the varying sums, giving rise to a serious upward bias to WTP estimates.[38]

There is also a problem of defining the "extent of the market," of determining the population to which the average WTP estimate, derived from a CVM survey, is to apply. Given the non-use (or passive use) characteristic of much of the value of many environmental resources, defining whether people living in different areas at varying distances from the environmental resource at issue do or do not value it may be quite arbitrary. The final estimate is, of course, likely to be very sensitive to this definition.

Although there are other problems, the one of embedding may be the most serious. As has now been repeatedly demonstrated, people usually indicate very different valuations for a particular entitlement depending on whether it is valued alone or first in combination with others. In one demonstration of this pattern, respondents indicated they would pay $123 to help provide "rescue equipment and trained personnel to deal with emergencies," if this was asked alone, but

---

[37] Knetsch, *supra* note 31.

[38] *See* M.J. Kealy and R.W. Turner, *A Test of the Equality of Close Ended and Open Ended Contingent Valuations*, 75 AMERICAN J. OF AGRICULTURAL ECONOMICS 321 (1993); W.H. Desvousges, F.R. Johnson, R.W. Dunford, K.J. Boyle, S.P. Hudson, and K.N. Wilson, *Measuring Natural Resource Damages With Contingent Valuation: Tests of Validity and Reliability, in* CONTINGENT VALUATION: A CRITICAL ASSESSMENT (J.A. Hausman ed., 1993); and Brown et al., *supra* note 36.

would value the same service at only $14 if derived from how much they would allocate to this purpose from a sum they had initially said they would pay for a larger bundle of services.[39]

The empirical evidence suggests that CVM studies are not successful at yielding even reasonably approximate or consistent estimates of environmental values, with the accuracy appearing to be worse for the kinds of resource for which such valuations are most needed. Institutional demands for "a number" have prompted improved techniques and more extensive— and expensive—tests, but results increasingly tend to be viewed as providing more in the way of indications or indexes of an attitude of good feeling for contributing to a public good than a measure of economic value.[40]

C. Incommensurable Values

The preceding discussion focused on the technical difficulties of current valuation techniques. There is, however, the further issue of the willingness and ability of people to value some environmental gains or losses in monetary terms—in other words, the extent to which people's valuations of components of the natural environment are commensurable with money. Definitions of incommensurability differ, but for the purposes of setting damage awards,

---

[39] D. Kahneman & J.L. Knetsch, *Valuing Public Goods: The Purchase of Moral Satisfaction*, 22 J. ENVIRON. ECON. MANAGEMENT 57 (1992). Other studies finding a similar discrepancy include I. Ajzen, T.C. Brown, and L.H. Rosenthal, *Information Bias in Contingent Valuation: Effects of Personal Relevance, Quality of Information, and Motivational Orientation*, 30 J. ENVIRON. ECON. MANAGEMENT 43 (1996); R. Gregory, S. Lichtenstein, T.C. Brown, G.L. Peterson & P. Slovic, *How Precise Are Monetary Representations of Environmental Improvements?*, 71(4) LAND ECON. 462 (1995); T.C. Brown & J.W. Duffield, *Testing Part-whole Valuation Effects in Contingent Valuation of Instream Flow Protection*, 31(9) WATER RESOURCES RES. 2341 (1995).

[40] A fairly tacit acknowledgment of the difficulties stemming from a combination of the use of the WTP rather than the WTA measure to assess losses, and from the use of hypothetical questions to elicit such values, was given in the nearly comical official proposal of USNOAA, which after much study and debate, recommended "[T]hat the respondents' stated values be divided by two, unless trustee can justify an alternative calibration factor for the specific case." USNOAA, NATURAL RESOURCE DAMAGE ASSESSMENT WORKSHOP MATERIALS 12 (1994). *See* Natural Resource Damage Assessments: Proposed Rules, 59 Fed. Reg. 1062, 1183 (1993). Of course, to the extent that the use of the WTP measure to assess losses, rather than the more appropriate WTA measure, results in a greater understatement of the sought after value than any overstatement due to hypothetical bias, the suggestion should call for multiplication instead of division by a number greater than one.

allocating environmental resources and creating incentives that are consistent with community goals, the main issues are the degree to which individuals can make trade-offs, especially between particular environmental changes and money, and the extent to which people can express environmental values in terms of a monetary metric.

Raz outlines a conception of incommensurability that offers little hope for reasoned choices among incommensurables: "A and B are incommensurate if it is neither true that one is better than the other nor true that they are of equal value."[41] He argues that incommensurability is displayed when people are intransitive in their choices among options; in other words, that intransitivity does not necessarily imply irrationality or hidden preferences, but instead may "reveal belief in incommensurability"[42]—a belief that some things cannot be directly compared.[43]

However, incommensurability need not be so absolute. Warner attributes incommensurability to an unwillingness to make trade-offs between the justifications for different actions.[44] For example, people may consider a need (or desire) for money as an acceptable

---

[41] J. RAZ, THE MORALITY OF FREEDOM 322 (1986).

[42] Id., at 325.

[43] In a somewhat related argument, H.A. David (who cites A. Tversky, *Instransitivity of Preferences*, 76(1) PSYCHOLOGICAL REV. 31 (1969)), explains intransitive responses to psychological preference surveys by suggesting that people may not have the cognitive ability to consistently compare some multi-dimensional objects. H.A. DAVID, THE METHOD OF PAIRED COMPARISONS (1988). David notes that the:

> simplest explanation is that the judge is at least partially guessing when declaring preferences. The judge may be guessing because of incompetence or because the objects are in fact very similar . . . . But guessing is not the only explanation, for there may be no valid ordering of the three objects when they differ markedly. Their merit may depend on more than one characteristic, and it is then somewhat artificial to attempt an ordering on a linear scale. Under these circumstances, the judge must mentally construct some function of the relevant characteristics and use this as a basis for comparison. It is not surprising that in complicated preference studies the function is vague and may change from one paired comparison to the next, especially when different pairs of objects may cause the judge to focus on different features of the objects.

Supra, at 3-4.

[44] R. Warner, *Incommensurability as a Jurisprudential Puzzle*, 68 CHI.-KENT L. REV. 147 (1992).

justification for working at a job, but not as a justification for selling a body part or betraying a trust. Similarly, some people may not consider money, or the things that money can buy, as justifiable compensation to allow aspects of the environment to be damaged or destroyed, or as necessary payment to preclude such damage or destruction.[45] Warner suggests, however, that sometimes it may be possible to make choices between incommensurables by changing evaluative attitudes, or deciding "what to allow and disallow as a reason for action."[46]

Others argue that observed difficulties in making certain types of comparisons do not necessarily imply that values are incommensurable. Regan, for example, suggests that a refusal to consider trading-off a given entity for money may simply be based on a judgment that the value of the entity is very much greater than money, rather than incommensurable with money.[47] In other words, the entity could be placed on a monetary metric of value, but it is worth *so* much that people resist expressing its value in monetary terms or contemplating a trade-off for money.

This difference—between an inability to make reasoned comparisons among goods or actions, on the one hand, and an unwillingness to trade-off one good or action against another, on the other hand—is significant for the present purpose of examining the potential of using judgments of importance to guide deterrence, design allocation policies, and compensate individuals who suffer harms. In particular, if comparisons among environmental losses cannot be made at all, then there is little chance that meaningful guidance about deterrence and compensation can be provided. However, if losses can at least be consistently compared—in

---

[45] Among other things, this provides a possible explanation of why some people respond to environmental valuation questionnaires with protest answers — they are not willing to consider the comparisons or tradeoffs proposed. For a discussion of this issue see C.R. Sunstein, *Endogenous Preferences, Environmental Law*, 12 J. LEGAL STUDIES 217, 248-53 (1993).

[46] Warner, *supra* note 44, at 168.

[47] D.H. Regan, *Authority and Value: Reflections on Raz's Morality of Freedom*, 62 S. CAL. L. REV. 995, 1058 (1989).

terms of importance or severity, for example—then we will be able to go the first step toward a useful scaling of these losses. It is not necessary, for this, that people be willing or able to either equate a loss with a monetary amount, or trade-off one loss against another.

Sunstein recognizes this distinction between comparability and commensurability, and is optimistic about the chances of meaningful comparisons:

> We might also believe that goods are comparable without believing that they are commensurable—that is, we might think that choices can be made among incommensurable goods, and that such choices are subject to reasoned evaluation, without believing that the relevant goods can be aligned along a single metric. Incommensurability need not entail incomparability.[48]
>
> . . . .
>
> . . . both people and societies do make choices among incommensurable goods, and they do so on the basis of reasons.[49]

Many people may well feel that environmental values are, at least to some degree, incommensurate with other private and public goals and objectives, in the sense that they are unwilling to consider giving up one to get the other. Nevertheless, these same people may be willing and able to compare those same items, if the comparison does not require trade-offs and does not require them to express their values in dollar terms. Incommensurability may pose a severe limitation on attempts to estimate monetary measures of environmental values, but it may not preclude the development of useful measures of the relative importance of different losses, thereby allowing "reasoned evaluations" to be better expressed in allocation guides and damage awards.

The existence and extent of incommensurability of environmental values is, of course, largely an empirical matter, and is the topic of section IV. But first, we consider some examples of the existing use of damage schedules.

---

[48] C.R. Sunstein, *Incommensurability and Valuation in Law*, 92 MICH. L. REV. 779, 798 (1994).

[49] *Id.*, at 811.

III. Existing Damage Schedules

Various forms of compensation schedules or damage schedules are presently being used to deal with non-pecuniary losses. Although clearly lacking the advantages that would stem from accurate monetary assessments of losses, if such were available, such compensation or damage schedules do offer some advantages of their own—such as predictability, lower costs, and general tractability—and enjoy a considerable measure of community acceptance. Standardized damage assessments for non-pecuniary losses are hardly new or novel,[50] nor are the issues and problems with schedules unique to environmental valuations.

A. Workers' Compensation Schedules

Under the typical workers' compensation scheme, the compensation that employees can recover for permanent workplace injuries is limited to "scheduled" amounts, which vary with the severity of the injuries suffered.[51] Although most workers' compensation schedules are intended to compensate primarily for economic losses such as lost wages and medical expenses, in many jurisdictions they also include, implicitly or expressly, compensation for the non-pecuniary losses of pain and suffering.[52]

---

[50] See, for instance, the definition of the term "wergild" in WEBSTER'S THIRD NEW INTERNATIONAL DICTIONARY OF THE ENGLISH LANGUAGE, 2597 (1986): "[T]he value set in Anglo Saxon and Germanic law upon the life of a man in accordance with a fixed scale increasing from the churl to the king and paid as compensation to the kindred or lord of a slain person or as a fine for some serious crime . . . ."

[51] As an illustration, the damage schedule established by the Workers Compensation Board in British Columbia, Canada, specifies a maximum possible award for cases of permanent total disability, and awards 2.5% of that maximum for the loss of a little finger; 15% for the loss of a kidney; and 35% for a frozen (immobile) shoulder. BRITISH COLUMBIA WORKERS' COMPENSATION BOARD, REHABILITATION SERVICES AND CLAIMS MANUAL (1993).

[52] See M. BERKOWITZ & J.F. BURTON, JR., PERMANENT DISABILITY BENEFITS IN WORKERS' COMPENSATION 20-22 (1987); and C.A. WILLIAMS, JR., AN INTERNATIONAL COMPARISON OF WORKERS' COMPENSATION 16-21 (1991).

The tradeoffs inherent in workers' compensation schemes are extensive. Generally, the employee gives up the right to sue an employer or fellow worker for personal injuries suffered at the workplace, and the right to have an ad hoc assessment of the value of injuries, in return for guaranteed, "no-fault," administrative recovery of an amount specified in the damage schedule. Similarly, the employer gives up the ability to defend individual claims on the basis of fault, but gains by avoiding expenses of defending claims, by being protected against windfall decisions, and by being able to participate in what is effectively a group insurance program.

The transaction costs and incentive mechanisms of the tort liability system are replaced by an administrative system which sets workplace safety standards, regulates compliance, and administers the pooled compensation funds. Financial incentives and deterrents for employers can be, and often are, provided by adjusting employer premium requirements in accordance with workplace safety records, using "experience ratings" based on the history of actual claims attributable to different industrial groups or firms (a growing trend in many jurisdictions).[53]

As workers' compensation schedules are designed principally to compensate pecuniary loss, they cannot be compared directly to non-pecuniary environmental damage schedules. However, the evident broad acceptance of workers' compensation schemes suggests that it is not unreasonable, in some cases, to set monetary damages for extremely difficult-to-value losses on the basis of the relative importance of the losses. Inherently, the compensation figures set by the workers' compensation schedules are based on perceptions of average losses and are, therefore, acknowledged to be inaccurate for any particular case. However, this is presumably acceptable, as the gains from predictability, efficiency, and dependability outweigh the losses from not tailoring awards to more accurately reflect specifics of individual cases.

B. Other Tort Reform Initiatives

---

[53] But see the comments of CANE, *supra* note 20, at 535-536, as to the questionable effectiveness of workers' compensation premiums as incentives.

Schedules of personal injury losses have been used in other areas of tort law as well, most commonly as a component of no-fault automobile insurance schemes.[54] Brown and Seto describe the schedules that have been implemented in Canadian jurisdictions that provide no-fault compensation for non-pecuniary losses:

> [T]hese no fault schemes provide benefits only for objectivity [sic] ascertainable impairment. This is done chiefly to reduce uncertainty and disputes (and thereby costs), but it is also probably true that in many cases the degree of impairment is a fair reflection of the relative pain, suffering and loss of enjoyment.

> The device used is a detailed schedule of impairment or disfigurement which assigns to each form of such impairment or disfigurement a percentage thereby indicating the degree of impairment of the whole body it is deemed to represent. That percentage is applied to a given maximum to determine the amount of the award.[55]

New Zealand took personal injury damage scheduling considerably further by replacing all tort liability with a statutory compensation scheme, including a compensation schedule encompassing non-pecuniary losses.[56]

Tort reform in the United States has been less dramatic.[57] However, the high transaction costs of the existing approach—in some areas more money may be spent in assessment and recovery than is paid to victims[58]—is providing pressure for further changes to the personal injury damages system. Sturgis summarizes the situation as follows: "the real question is whether the

---

[54] *See* J.Y. KING, NO-FAULT AUTOMOBILE ACCIDENT LAW (1987).

[55] C. BROWN & E.C. SETO, NO-FAULT AUTOMOBILE LIABILITY INSURANCE IN CANADA 125 (1988).

[56] Accident Compensation Act, N.Z. Stat. 1972, No. 43. Note, however, that in 1992 the range of injuries and losses covered under New Zealand's statutory scheme was scaled back. *See* M.A. McGregor Vennell & J. Manning, *Accident Compensation*, 1992 NEW ZEALAND RECENT LAW REVIEW 1.

[57] Possibly due to constitutional restrictions. *See* R.R. Bovbjerg, F.A. Sloan & J.F. Blumstein, *Valuing Life and Limb in Tort: Scheduling "Pain and Suffering,"* 83 NW. U. L. REV. 908 (1989).

[58] J.G. FLEMING, THE AMERICAN TORT PROCESS 19 (1988).

intended to ensure that injuries that are relatively equivalent in terms of severity receive relatively equivalent compensation.[62]

C. Environmental Value Schedules

1. Replacement cost tables and civil penalties

Scheduling initiatives aimed at standardizing natural resource damage assessments and reducing assessment costs are not uncommon in the United States. A survey of state fish and game departments and state Attorneys General conducted about fifteen years ago found that nine states had formally adopted fish damage schedules based on replacement cost calculations, and an additional thirteen states used tables of replacement cost as informal guides for assessing damages.[63] The pre-established and standardized sums of these replacement cost tables, to be charged on a per organism basis, made damage assessments more consistent, predictable and less costly.

The same survey revealed that some jurisdictions, rather than relying on a notion of value such as replacement cost, instead set monetary charges for lost fish and wildlife that, while reflecting some perception of relative importance, were anchored to dollars in a rather arbitrary way. Thus, as in the case of civil penalties for illegally taking wildlife in South Dakota and Wisconsin, "The amount charged . . . generally does not purport to represent any actual 'value' of a given species."[64]

---

[62] The personal injury award matrix proposed by Bovbjerg et al., *supra* note 57, resembles that proposed herein for environmental losses, but their matrix is based on past awards rather than judgments of relative importance. If part of the variability in jury awards is due to difficulty in expressing non-pecuniary values in dollar terms, then a matrix based on past awards may institutionalize errors, rather than progressing toward a representation of real values.

[63] F. Halter, & J.T. Thomas, *Recovery of Damages by States for Fish and Wildlife Losses Caused by Pollution*, 10 ECOLOGY L. QUARTERLY 5 (1982).

[64] *Id.* at 21.

The use of such civil penalties and replacement cost tables for wildlife losses seems to be expanding, at least in the United States. The 1993 version of the *State Wildlife Laws Handbook* notes:

> In addition to criminal penalties, over one-third of the states have civil liability provisions of some kind . . . . Although it is difficult to assess the value of wildlife, half the state legislatures have assessed a value of wildlife for civil liability purposes. These states list the value of various important wildlife species and require the violator to pay restitution to the state for the value of each such animal taken.[65]

In addition, in some states these pre-established charges for environmental harms are based on measures of value that are more extensive than replacement cost. For example, according to Plante et al., Texas has ranked species pursuant to a set of eight criteria of value (such as recreational, aesthetic, economic and ecological role), and then converted the rankings to a monetary liquidated damages scale.[66]

2. More extensive damage schedules

Damage schedules are also being used to assess environmental losses arising from spills of oil or other harmful liquids. However, these schedules do not set out the compensation charges on a per organism basis, but instead attempt to more broadly quantify and standardize the expected damage from a given spill in a given area. Generally, damage assessment formulae are specified in terms of the type and volume of liquid spilled and the type of environment affected. At least five examples of volume-based damage valuation schedules exist or have been proposed in the United States: (i) Florida's Pollutant Discharge Natural Resource Damage Assessment Compensation Schedule;[67] (ii) Washington State's Preassessment Screening and Oil Spill Compensation

---

[65] R.S. Musgrave, & M.A. Stein, State Wildlife Laws Handbook 30 (1993).

[66] Plante et al., *supra* note 7, at 717.

[67] Pollutant Discharge Prevention and Control Act, Fla. Stat. § 376.121 (1994).

Schedule Rule;[68] (iii) the federal "Type A" assessment computer models established under CERCLA;[69] (iv) the compensation formulae that were proposed by USNOAA in 1994 for use under OPA (and subsequently abandoned);[70] and (v) a volume-based damage assessment statute proposed in New York State in 1994, but not approved.[71]

The U.S. federal volume-based assessment schedules have not attempted to express all values for environmental assets. The compensation formulae originally proposed by USNOAA, for example, were designed to provide "an estimate of damages per gallon taking into account average restoration costs, plus average lost direct use values pending restoration."[72] Passive use values were not included, based on the following reasoning: "Passive use (nonuse) values are currently not included in the formulas, since, at the time of their development, NOAA determined that sufficient information did not exist concerning average passive use values, applicable to the compensation formula approach."[73] The original CERCLA Type A damage assessment computer

---

[68] *Supra* note 6.

[69] *Supra* note 2.

[70] *See* Natural Resource Damage Assessments: Notice of Proposed Rulemaking, 59 FED. REG. 1062 (1994). The proposed USNOAA compensation formulae were eventually abandoned in favor of an approach based principally on restoration or replacement. *See* Natural Resource Damage Assessments: Notice of Proposed Rulemaking, 60 FED. REG. 39803 (1995); C. Jones, *The New Restoration-Based Measures of Compensation in Natural Resource Damage Assessment Regulations: Methodological Challenges*, 16(1) AERE NEWSLETTER, May 1996, at 5.

[71] *See* An Act to Amend the Environmental Conservation Law and the State Finance Law, in Relation to Enacting the Pollutant Discharge Prevention & Control Act of 1994, 1994 N.Y. LAWS A10023. Alaska has also established volume-based charges for oil spills, but the charges are expressed as civil penalties, and it is not completely clear whether those penalties are intended to represent environmental values. *See* Environmental Conservation Act, ALASKA STAT. § 46.03.758 (1995); Oil and Hazardous Substances Pollution Control Regulations, ALASKA ADMIN. CODE. Title 18, § 75.500 (1995). This may, however, be a device to discourage legal challenges to the "valuation" methodology.

[72] USNOAA, OFFICE OF GENERAL COUNSEL, DAMAGE ASSESSMENT REGULATIONS TEAM, OVERVIEW OF THE PROCESS 13-14 (1994).

[73] Natural Resource Damage Assessments: Notice of Proposed Rulemaking, 59 FED. REG. 1062, 1119 (1994).

models also omitted non-use values.[74] In addition, the direct use values expressed in the federal

schedules incorporate whatever inaccuracies that may have been introduced by relying on

contingent valuation surveys.[75]

The drafters of Florida's oil spill compensation schedule accepted that assigning dollar

figures to non-pecuniary losses is largely an arbitrary process:

> As elected officials, it was the legislature's collective opinion that they were in the best
> position to assign a monetary value to the state's natural resources. Recognizing that such
> a value may not represent the true value of the resources, it was determined that
> assignment of a specific value would, at a minimum, eliminate the speculative nature of the
> damages and provide a basis for which monies needed to restore natural resources would
> not be tied up in seemingly endless litigation, but would be channeled into the environment
> as expeditiously as possible.[76]

The Florida schedule sets out a compensation formula in which the volume spilled is multiplied by

a number of factors designed to adjust for the variation in harm that will arise from differences in

spill location, pollutant characteristics and habitat factors.[77] The formula is intended to substitute

for a broad spectrum of environmental values: "The compensation schedule is based upon the loss

of ecological, consumptive, intrinsic, recreational, scientific, economic, aesthetic, and educational

values of injured or destroyed resources."[78] As with the criteria used by Texas for valuing wildlife

species, the recognition of different categories of value allows the expression of aspects of the

---

[74] *See* Grigalunas & Opaluch, *supra* note 4.

[75] *See, e.g.,* M. Welsh, R. Bishop, G. Brown and E. MacDonald, *Fish and Wildlife Economic Model and Data, in* USNOAA, OFFICE OF THE GENERAL COUNSEL, DAMAGE ASSESSMENT REGULATIONS TEAM, COMPENSATION FORMULA FOR NATURAL RESOURCE DAMAGE ASSESSMENTS UNDER OPA: OIL SPILLS INTO ESTUARINE AND MARINE ENVIRONMENTS, Volume II (1994).

[76] Plante et al., *supra* note 7, at 718.

[77] *Id.*

[78] *Id.* at 719.

importance of environmental assets that may not be picked up by typical monetary estimates. However, Plante et al. also note that the multipliers used in the Florida schedule are based on "restoration cost and market value-based loss of use."[79] To the extent these were the only measures of value that were considered in developing the dollar figures used in the schedules, significant components of value may still have been missed.

Washington State's compensation schedule seems to abandon links to conventional economic valuation models entirely, and instead categorizes spills on the basis of two main components: "resource vulnerability ranking," which considers the relative sensitivity of the particular receiving environment, and "oil effect ranking," which gives an indication of the relative severity of environmental harm that the type of oil spilled is likely to cause.[80] The derivation of the "rankings" is complex, but generally the resource vulnerability measure incorporates ratings (on a scale of 1 to 5) of habitat, marine birds, marine fisheries, shellfish, salmon, marine mammals, and recreation, and the oil effect measure incorporates five-point ratings of acute toxicity, mechanical injury, and environmental persistence. The damage schedule combines measures of these two components in a multi-term formula that is scaled to produce compensation figures ranging from one to fifty dollars per gallon of spilled oil.[81]

The Washington State categories and "rankings" are more indicative of ecological importance and sensitivity than of estimates of monetary value in the traditional sense. For example, the marine fisheries vulnerability scores are calculated based on five-point ratings related to the following ten factors: (i) presence and usual abundance; (ii) current stock condition; (iii) importance to commercial fisheries; (iv) importance to recreational fisheries; v) importance as a

---

[79] *Id.* at 720.

[80] Geselbracht & Logan, *supra* note 4.

[81] *Id.*

prey or indicator species; (vi) normal distributional range; (vii) adult sensitivity measured by depth of occurrence; (viii) larval sensitivity as measured by presence and depth of occurrence in a particular season; (ix) egg sensitivity as measured by presence and depth of occurrence in a particular season; and (x) season.[82] Although commercial fisheries and recreational fisheries are included in this vulnerability score calculation, they are rated in terms of "importance" rather than monetary value, and are equally weighted with such other factors as "importance as a prey or indicator species."

Washington's damage schedule scheme suggests the potential for using scores of relative importance to assess damages. But the Washington schedule deals more with aspects of physical and biological importance than with social importance. For example, the recreational value rating contributes only one-seventh of the overall spill vulnerability score, and the six other variables are all biologically oriented (although recreational and commercial fisheries ratings are incorporated in the marine fisheries score, and average annual harvest is incorporated in the shellfish score).[83] The schedule may not fully reflect how the public would weigh the different categories involved, or would weigh the different losses within each category.

Arguably the amount charged for damage to a public asset should bear a relationship to the aggregate *social* value of the loss. The Washington formula was established by experts and interest groups, including federal and state resource agencies, Indian tribes, affected industries and environmental organizations.[84] Similarly, Florida's system was developed by researchers and staff from the Florida Department of Natural Resources, using a nominal group technique.[85] It may be

---

[82] *Id.* at 8-9.

[83] *Id.* at 4-19.

[84] *Id.* at 3.

[85] Plante et al., *supra* note 7, at 718.

that government staff, experts, and interest groups can estimate aggregate social value, but this is far from generally accepted or agreed upon. Nor is it clear that government staff, experts, and representative members of the community will agree on scores of relative importance.

IV. Judging Non-Pecuniary Losses

The compensation figures set out in the existing environmental damage schedules discussed above were set in accordance with judgments of physical and biological importance made by government staff, experts and interest groups, or were derived from contingent valuation surveys or other valuation methods that have limited applicability or provide at best questionable indications of value. Although such approaches—especially to the extent they are able to rely on measures such as replacement cost, restoration cost, hedonic pricing and travel cost methods— may be useful for assessing values in limited circumstances, these schedules could be made more useful and more appropriate if supplemented with methods that capture other components of value, and that more clearly reflect aggregate changes in social well-being associated with the loss or change in environmental quality. If consistent judgments of environmental importance can be elicited directly from the public, a damage schedule based on those judgments might provide more accurate and acceptable signals of community values.

This section discusses the results of a survey in which respondents were asked to make choices between pairs of non-pecuniary environmental losses. The survey examined the ability of individuals to consistently choose between pairs of reasonably familiar non-pecuniary environmental losses of similar type, in a single context.[86] The results were used to construct an

---

[86] In a previous paired comparison survey of university students judging a mix of public goods, private goods, and sums of money, conducted by Peterson & Brown, the overall coefficient of consistency for the sample of 330 respondents was 90%, and half of the respondents had a coefficient of consistency of at least 94%. *See* G.L. Peterson & T.C. Brown, Economic Valuation by the Method of Paired Comparison, with Emphasis on Evaluation of the Transitivity Axiom, (1996) (unpublished manuscript, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado).

aggregated interval level scaling of the relative importance of these losses, in a form that could be used to develop an interim damage schedule.

A. Methodology

A questionnaire was mailed to alumni of the graduate program in Resource and Environmental Management at Simon Fraser University ("REM graduates"). Responses were received from 52 REM graduates.[87]

The questionnaire focused on four different environmental losses resulting from oil spills. The four losses were presented in pairs and respondents were asked to choose the loss in each pair for which the greater amount of compensation should be paid. All possible pairs of the four losses were presented, resulting in six comparisons, following common procedures of the method of "paired comparisons."[88]

The method of paired comparisons is a well established psychometric method for ordering preferences among the elements of a choice set. Given a set of objects, the method presents them independently in pairs as discrete binary choices. Pair-wise comparison of elements of a choice set reveals inconsistent choices as circular triads, that is, choices that imply $A>B>C>A$. If the respondent produces no circular triads, the result will be a perfect rank ordering of the objects. A choice must be made even if the respondent is indifferent between the two objects in a pair. Across respondents, or across repetitions of the choice for the same respondent, indifference is

---

[87] The response rate for this survey was 51 percent. However, as the study was not intended to obtain a representative "sample" of the students, the response rate is not especially relevant. The group of respondents that actually returned completed questionnaires was, for the purposes of the study, a full population. Accordingly, the study results should not be interpreted as representative of REM graduates as a whole, but only as representative of the group of REM graduates who completed and returned questionnaires.

[88] *See* G.T. FECHNER, ELEMENTE DER PSYCHOPHYSIK (1860); L.L. Thurstone, A *Law of Comparative Judgment*, 34 PSYCH. REV. 273 (1927); J.P. GUILFORD, PSYCHOMETRIC METHODS (2nd ed., H.F. Harlow ed., 1954); P. DUNN-RANKIN, SCALING METHODS (1983); SCALING: A SOURCEBOOK FOR BEHAVIORAL SCIENTISTS (G.M. Maranall ed., 1974); H.A. DAVID, THE METHOD OF PAIRED COMPARISONS (Alan Stuart ed., 1988); Peterson & Brown, *supra* note 86.

indicated by an equal number of selections of each object in the pair. However, a lack of consistency in choice may not be due to indifference, but rather to systematic intransitivity, which is also allowed for by the paired comparison method.[89]

Respondents were given the following instructions:

Oil spills cause environmental damage. In some cases damage payments will be paid, and the amount of these payments may vary according to the relative seriousness of the environmental damage caused by the spill.

For each pair of publicly owned locations described below, select the one for which you feel that greater damage payments should be made in the event of a spill of 100,000 litres of crude oil in mid-summer. Assume that commercial and recreational fisheries are not affected by the spills, and that it takes approximately two years for all oil to dissipate or be removed from the environment.

Do not indicate a dollar amount, just put a check beside the spill location for which you think that greater damage payments should be made.

The following oil spill damage scenarios were described:

1. An area at the mouth of a river with mixed sand and mud beaches and low marshes. Marine bird populations are high, marine mammal populations are high, and recreational use of the area is low.

2. A deep bay at the mouth of a river. Marine bird populations are low, marine mammal populations are moderate, and recreational use of the area is high.

3. A sandy ocean beach close to a city. Marine bird populations are low, marine mammal populations are low, and recreational use of the area is high.

4. An area of open ocean on the outer continental shelf. Marine bird populations are low, marine mammal populations are low, and recreational use of the area is low.

All six possible pairs of the four loss scenarios were presented for choice in random order,[90] and respondents selected one from each pair of losses as being more important, in the sense that a larger amount of compensation should be paid for it than for the other.

---

[89] See note 43 and accompanying text for more on intransitivity.

36

The descriptions of oil spill sites used in the questionnaire, and the parameters used to describe oil spill damage, were loosely based on the Washington State compensation schedule.[91] The Washington State system was used as a model because it includes marine and estuarine conditions that are similar to those in British Columbia (where the REM graduates had attended university), and it does not use site descriptions that depend on locally defined terms, such as "state game refuges"[92] or "special management areas."[93] In order to make the questionnaire less complex than the Washington State classification scheme, respondents were given only a brief written description of each spill site and of the relative magnitude of three characteristics of resource vulnerability: marine bird populations; marine mammal populations; and recreational use. The oil spill settings were hypothetical, but realistic, and could be assigned approximate numerical rankings under the Washington State scheme for comparison.

Several other factors, such as spill size (100,000 litres), oil type (crude), season (mid-summer), dissipation time (two years), and effect on commercial and recreational fisheries (none), were held constant among the choices. The intent in simplifying and standardizing oil spill and habitat descriptions was to provide sufficient information for informed choices without overloading respondents or forcing them to make variable assumptions. Written descriptions of spill sites were included in order to evoke feelings of intrinsic values, and to encourage respondents to do more than just add up the verbal "low," "medium" or "high" rankings of

---

[90] The ordering of paired comparison "stimuli" may be arranged in accordance with Ross's Matrix to minimize space and time biases. *See* R.T. Ross, *Optimal Orders in the Method of Paired Comparisons*, 25 J. EXP. PSYCH. 414 (1939). However, randomization is also valid if both the order of the pairs and the position of the objects in the pairs is randomized; see DUNN-RANKIN, *supra* note 88, at 16.

[91] Preassessment Screening and Oil Spill Compensation Schedule Rule *supra* note 6.

[92] Used in Alaska's Oil and Hazardous Substances Pollution Control Regulations, *supra* note 71.

[93] Used in Florida's Pollutant Discharge Prevention and Control Act, *supra* note 67.

resource vulnerability. Vulnerability rankings were given in words rather than numbers for the same reasons. The spills were framed as "damage" to "publicly owned locations" in order to evoke a sense of loss, and to elicit non-use as well as use values within the given parameters.

B. Results

1. Simple rankings

One of the simplest ways to evaluate paired comparison data is to derive from each set of consistent choices a ranking for the "stimuli" being evaluated.[94] For example, if a respondent selected "marsh" in three questions, "deep bay" in two questions, "ocean beach" in one question, and did not select "outer shelf" in any question, the ranking would be: marsh, deep bay, ocean beach, outer shelf (progressing from highest importance to lowest). Since each loss in the questionnaire was paired exactly once with each other loss, each loss had an equal chance of being selected zero, one, two or three times by each respondent.

Ninety-six percent of the respondents made consistent choices between all pairs of oil spill losses presented. The most commonly selected rank order, from most important to least important, was: marsh, deep bay, ocean beach, outer shelf.

2. Scale values

Paired comparison data can also be aggregated and scaled using psychometric scaling methods. For the purposes of this preliminary survey, simple aggregate scalings were calculated on the basis of relative dominance, using the "variance stable rank method" proposed by Dunn-Rankin.[95] Peterson and Brown[96] used a relative dominance scaling technique similar to the

_____

[94] DUNN-RANKIN, *supra* note 88, at 93; Peterson & Brown, *supra* note 86.

[95] P. Dunn-Rankin, The True Distribution of the Range of Rank Totals and Its Application to Psychological Scaling, (1965) (Unpublished doctoral dissertation, Florida State University, Tallahasee), cited in DUNN-RANKIN, *supra* note 88. *See also* DUNN-RANKIN, *supra* note 88.

[96] *Supra* note 86.

variance stable rank method, and Dunn-Rankin[97] notes that similar techniques have been proposed by Mosteller,[98] Guilford[99] and Rummel[100].

To apply the variance stable rank method, the total number of times that each loss is selected by all respondents is divided by the maximum number of times that it could have been selected, and the result is multiplied by 100. This gives an ordering of the losses on a scale of 0 to 100, with a mean value of 50. This ordering approximates an interval scale measure, rather than a ratio scale measure. Although forty units on the scale represent twice as much importance as twenty units, the ratio of 80 to 40 is not necessarily the same as the ratio of 40 to 20. Also, the maximum possible score on the scale is not necessarily one hundred, and zero does not represent a complete absence of value or importance.[101]

Table 1 shows the survey data scaled pursuant to the variance stable rank method. Table 1 also shows rough estimates of how each of the oil spill scenarios used in the survey might score in terms of relative severity under the Washington State compensation schedule.[102]

---

[97] DUNN-RANKIN, *supra* note 88, at 56.

[98] F. Mosteller, *The Mystery of the Missing Corpus*, 23(4) PSYCHOMETRIKA. Cited in DUNN-RANKIN, *supra* note 88.

[99] GUILFORD, *supra* note 88.

[100] R.J. RUMMEL, AN INTRODUCTION TO RESEARCH PROCEDURES IN EDUCATION (1964). Cited in DUNN-RANKIN, *supra* note 88.

[101] Similarly, in the Celsius scale of temperature the zero point does not represent a complete absence of temperature or heat.

[102] In order to allow a rough comparison of the REM graduates survey results to the Washington State compensation schedule, the verbal descriptions of habitat vulnerability used in the survey were assigned numerical values corresponding to the Washington State scheme—five points were assigned to "high," three points were assigned to "moderate," and one point was assigned to "low"—and the resulting figures were summed to give an aggregate score for each spill. For example, the spill into a deep bay at the mouth of a river was assigned one point for marine bird populations (low), three points for marine mammal populations (moderate), and five points for recreational use (high), for an aggregate score of nine.

Table 1.

Oil Spill Damage Scalings

	Scale Values From Sample	Washington Compensation Schedule Approximate Score
Marsh	91	11
Deep Bay	57	9
Ocean Beach	48	7
Outer Shelf	4	3

C. Discussion

The overwhelming majority of the respondents were able to consistently choose among all pairs of oil spill losses presented. This implies, at least for this sample group, that rational, internally consistent, choices can be made among these types of non-pecuniary losses—when the losses are familiar and of a similar type, the assets are broadly spaced in the overall spectrum of individual values, and the information given concerning the damage and the attributes of each asset is simple and easy to understand. The results compare favorably with those of Peterson and Brown.[103]

---

[103] *Supra* note 86. Two differences between the current study and that of Peterson & Brown should be noted. First, in the present survey, respondents were able to "check back" against previous answers, which would be expected to improve consistency. Peterson & Brown used a computer program to administer the paired comparison choices, so that subjects could not go back to previous choices. Second, the current survey included only four elements in the choice set, versus 21 in the Peterson & Brown study. The more elements in the set, the less likely it is that respondents can rely on memory of prior choices as an aid in making a given choice. Nevertheless, in the Peterson & Brown study the overall coefficient of consistency across the 330 respondents was 92%.

It is likely that individuals would have more difficulty being consistent in choosing between non-pecuniary losses if the losses were closer together in relative value, more complex or unfamiliar, or from more divergent dimensions of value (for example, oil spill damages compared to personal injuries). Inconsistency may, as indicated earlier, simply indicate closeness in relative value; across numerous respondents, such closeness is indicated by closeness in scale values. Inconsistency may also indicate systematic intransitivity. If such intransitivity is due to the confusion generated by complex or unfamiliar loss scenarios, it can be dealt with to some degree by carefully designing the way in which information is conveyed to respondents. In the present survey, for example, oil spill losses were described mainly in terms of simple physical and biological characteristics; but if questions included more variation in the type of hazardous substance spilled, in spill size, or in other factors that would alter the relative effect on different resources, losses might instead be described in terms of changes in service flows or impacts (based on expert evaluations) to assist subjects in understanding those effects.

Intransitivity caused by inability to make comparisons across divergent dimensions of value, to the extent that such an inability exists, is a more difficult problem. The extent to which rational choices can be made across contexts and dimensions of value is a fundamental issue in the construction of value scales, as it determines which types of assets or losses can be reliably compared and represented in one scale of relative importance, and which must be separated into unique scales. This topic deserves further empirical investigation.

V. DEVELOPING AN INTERIM DAMAGE SCHEDULE

A. Establishing Preference Judgments

The first step in constructing an importance scale and interim environmental damage schedule based on people's preferences—rather than arbitrarily set by administrative fiat—is to establish the relative importance of the non-pecuniary assets or losses under consideration. The

survey reported in the previous section explored one promising technique for doing this. Other approaches include using a rating technique or conjoint analysis.[104]

Two additional interrelated issues arise in establishing social preference judgments for environmental losses: (i) What sample of respondents best reflects community assessments of the relative importance of different losses? and (ii) What characteristics (or attributes) of activities and losses should be taken into consideration? A major concern is the choice between respondents who may have particular expertise, but may weigh alternatives differently from other members of the community, and respondents who may better reflect community values but lack the knowledge or information necessary to make informed choices. A number of factors may cause divergence in the judgments of these two groups, particularly with respect to perceptions of risk and the activities that may cause losses.[105]

Risk assessment studies have demonstrated that experts often assess the significance of events in ways that differ markedly from the assessments of lay people.[106] Experts strongly focus on the magnitude of an expected loss (the probability of occurrence multiplied by the value of the loss if it occurs) in assessing relative importance. Non-experts tend to consider this as only one attribute, and in addition weigh characteristics such as whether a risk is assumed voluntarily or imposed, whether it affects future generations or not, and the extent to which it is controllable by the individuals affected.[107] Such differences in perspective are common and are important in

---

[104] *See* P.E. Green and V. Srinivasan, *Conjoint Analysis in Consumer Research: Issues and Outlook,* 5 JOURNAL OF CONSUMER RESEARCH 103 (1978); P.E. Green and V. Srinivasan. *Conjoint Analysis in Marketing: New Developments with Implications for Research and Practice,* 54 JOURNAL OF MARKETING 3 (1990).

[105] For a detailed analysis of this issue, in the context of risk regulation, see R.H. Pildes & C.R. Sunstein. *Reinventing the Regulatory State,* 62 U. CHI. L. REV. 1, 43-95 (1995).

[106] P. Slovic, *Perceptions of Risk,* 236 SCIENCE 280 (1987).

[107] *Id.*

valuing risks and losses. They may result from different information, or interpretations of facts; from different subjective calculations, particularly concerning the reluctance of many people to disregard even low probability events; or from different levels of trust that cleanup activities will be as thorough or as speedy as suggested.

The preferences of non-experts are not necessarily irrational or uninformed when they differ from those of experts. Although in some cases the lay public may be confused, or may base their choices on erroneous facts or interpretations, in many cases they may differ from experts simply because particular dimensions or characteristics of losses or potential events are important to them beyond the narrower calculations of probabilities and expected losses on which expert judgments are largely based. In other words, lay people's preferences may express important attributes of value and perspectives toward risk that are not taken into account by experts. This point is illustrated by the finding that people may be willing, on average, to spend three times as much to prevent a cancer death than to prevent an immediate death from other causes.[108]

In the assessment of social values, lay preferences are important when real differences in valuation, rather than confusion, cause variations from the preferences of experts. As Pildes and Sunstein suggest:

> If lay assessments rest on factual misinformation, or on cognitive distortions in the way inferences are drawn from the known facts, they need not be credited. But to the extent that they reflect different valuations of risk, such as concern for how equitably distributed a risk is, or whether the processes by which the risk is imposed and managed are fair, they are the kind of citizen preferences, backed up by legitimate reasons and values, that democracies should take seriously.[109]

Such citizen preferences about risk, and about other characteristics of losses, can be reflected in judgments of the relative importance of different environmental losses, if the potential losses are

---

[108] Pildes & Sunstein, *supra* note 105, at 73.

[109] Pildes & Sunstein, *supra* note 105, at 73.

described in terms of the activities involved, the assets potentially affected and the types and probabilities of harm. The preferences might then express not only the relative social importance of the environmental losses, but also social perceptions about the relative significance of the risks involved.

A related issue is the extent to which cause of a loss (independent of its effect on perceptions of the risk involved) should influence relative weights of the loss. People may well feel that the death of 20,000 seabirds is more serious if caused by the deliberate action of individuals, or if caused by negligence, as opposed to it being the result of natural events. The loss, in terms of physical or biological consequences, may be the same, but the impact on people's well-being may be quite different, and again the judgments of experts and lay people may vary. Whether these differences should influence the relative weight assigned to the losses for the purposes of damage assessment is less clear than for perceptions of risk, but as with risk, the appropriate policy should probably reflect the degree to which an accounting for cause better serves the allocation, deterrence, and compensation objectives of loss assessments.

Given that the preferences of lay people can be important, but are more difficult to elicit than those of experts, a commonly suggested alternative is to select respondents from a collection of interest groups involved in environmental issues—so-called stakeholders. However, even when selected from a broad array of interests, stakeholders may not represent a complete or proportionate sampling of all of the attitudes and preferences of society with respect to such issues; and characteristically do little to adequately represent broad and more diffuse interests of the wider community. Moreover, the preferences of the representatives of any given interest group may fail to accurately express the preferences of the members of the group itself. There is certainly no reason to expect that the importance attributed to an asset by the representatives of an interest group will reflect a statistically weighted summation of the importance that would be attributed to it by each member of the group. The preferences of the representatives may differ even from the preferences of the majority of the group's members, due to organizational

incentives acting upon group leaders. Consequently, interest group representatives may not be the best source of aggregate social preference information.

The potential for variation among the assessments of interest groups, experts and lay people suggests that, when possible, the importance scales might best be based on preferences elicited directly from non-expert members of the public, who bear the consequences of decisions based on these weightings.[110] However, some effort does need to be made to minimize the distorting effects of confusion in non-expert judgments. A variety of methods exist for determining lay preferences, from simple surveys or opinion polls to lengthy exchanges between experts and lay people in which factual and cognitive errors are directly addressed. The paired comparison survey discussed in Section IV falls somewhere between these extremes, as some degree of scientific information about the consequences of specific losses can be conveyed to respondents. It has the additional advantage of allowing for inconsistency to be revealed in the data, providing a direct post-survey assessment of the "quality" of the sample's responses.

The point is to establish some form of consensus concerning the relative social importance of adverse environmental outcomes or consequences of an event or activity—the importance of a temporary loss of a stretch of beach resulting from a spill relative to, for example, the decrease in fish populations in a stream brought about by runoff from urban construction. Even when the losses to be compared are taken as certain, there may well be uncertainty over possible relationships of some such outcomes and other consequences—the decrease in fish populations, for example, may or may not have an impact on birds or mammals in the area. An appropriate role for experts might be to provide information about the consequences of the environmental harms

---

[110] This does not mean that lay preferences must always be followed. The objective of determining social rankings of importance is to provide decision makers with accurate information about social values and preferences, not to replace political decision making processes with public opinion polls. There may be circumstances in which decision makers will elect not to abide by lay preferences, but they should not have to guess at what those preferences are.

to be considered, and the uncertainties involved, so that non-experts can base their choices about relative importance on the best available information.[111]

B. Developing the Importance Scales

Once the relative importance of the several environmental losses under consideration has been empirically established, the weighting of each individual loss can then be related to the factors that influence these weightings. In addition to the more controversial "type of risk" and "nature of the cause of loss" characteristics discussed above, these factors might include some measure of physical impact, the location, time of year, the use of the area, and the severity of the consequences of the individual harms.[112] The factors might be set out along a scale, with particular points on the scale corresponding to the relative importance of a loss described by the combination of characteristics associated with that loss.

The use of such a scale of importance can be illustrated with the scale value of 91 given by the survey respondents to oil spilled at an area of "sand and mud beaches and low marshes." The 91 would appear on the scale as the relative importance of: a crude oil spill; 100,000 litres; mid-summer; river mouth with mixed sand and mud beaches and low marshes; no commercial fisheries; no recreational fisheries; high marine bird populations; high marine mammal populations; and low recreational use. In contrast, the scale value of 48 given by the respondents would appear on the importance scale representing the characteristics: crude oil spill; 100,000 litres; mid-

---

[111] For an example of expert classification of environmental assets on the basis of the environmental functions (or "goods and services") that they provide, see R.S. DE GROOT, FUNCTIONS OF NATURE: EVALUATION OF NATURE IN ENVIRONMENTAL PLANNING, MANAGEMENT AND DECISION MAKING (1992); and for an example of a system used to weigh the relative significance of areas for wildlife conservation, see M.B. USHER, WILDLIFE CONSERVATION EVALUATION (1986). The extensive research on risk communication might be used to design the mode for communicating this type of scientific information to lay rankers.

[112] In comparison, the matrix proposed by Bovbjerg et al., *supra* note 57, for assessing non-economic losses arising from personal injuries uses the criteria of age of the injured party and severity of the injury.

summer; sandy ocean beach close to a city; no commercial fisheries; no recreational fisheries; low marine bird populations; low marine mammal populations; and high recreational use.

The principal advantage of expressing preference results in a scale of importance is that the community judgments of the importance of particular losses is seen to depend on specific variables. Further, as all possible losses could not possibly be assessed in the same survey, an initial scale with a few specific losses would provide a framework of reference points to establish the relative importance of other harms. As other harms are encountered their relative importance can be estimated by interpolation and extrapolation from those previously assessed. For example, if the initial scale included the scale value described above for a crude oil spill at a sandy ocean beach, and in fact an identical crude oil spill occurred in an area with similar characteristics except for the presence of a moderately high population of marine birds, the unassessed spill might be assigned a higher importance than the previously assessed spill. If, instead, the spill were in a similar area with low marine bird populations and low recreational use, the new spill might be assigned a lower importance than the assessed spill. In either case, the importance assigned to the new spill would then provide an additional point within the ranking scale for use in later comparisons.[113]

C. Developing the Interim Damage Schedule

To construct an environmental damage schedule from the importance scale, the scale value scheme would be assigned a "location" within the overall range of policy measures and dollar values designed to provide the desired incentives and remedies. As in the case of existing damage schedules, this might be done by legislative or administrative bodies. The level of sanction,

---

[113] This process of continuing interpolation and extrapolation appears to be characteristic of the existing personal injury damage schedules reviewed earlier. The present rich detail of individual harms seems to be the product of years of cases that were somewhat like and somewhat different from previous cases, and new damages were established accordingly.

deterrence or compensation facing those responsible for environmental losses would vary in keeping with the relative severity of the loss.

Damage awards of varying levels would no doubt be included among the instruments, but these would likely be best used along with prohibitions and other lesser restrictions and remedies. Losses judged to be of the greatest importance might, for example, justify absolute prohibitions on particular activities in areas that would give rise to the possibility of such losses being encountered. For example, oil tankers might be prohibited in areas where their presence, and the consequent possibility of a spill, would put particularly sensitive and very important environmental assets at risk. At the other end of the spectrum, losses judged to be of minor importance might call for minimal deterrence in the form of small damage awards, or small charges for use, or for the absence of any restriction.

Figure 1 provides a schematic representation of how a selection of potential policy responses might be located along an importance scale. In the center of the figure the available policy responses are laid out, ranging from the least severe at the bottom to the most severe at the top. In this case, the less severe responses involve liability rules, requiring the payment of damages for harms. The more severe responses impose property rules, protected by absolute prohibitions on use, backed by injunctive remedies. On the left side of the diagram the scaled values of the survey respondents in the oil spill survey are set out. Based on those values, the least severe remedy would be assigned to the Outer Shelf oil spill location and damage description, and the most severe remedy would be assigned to the Marsh oil spill location and damage description.
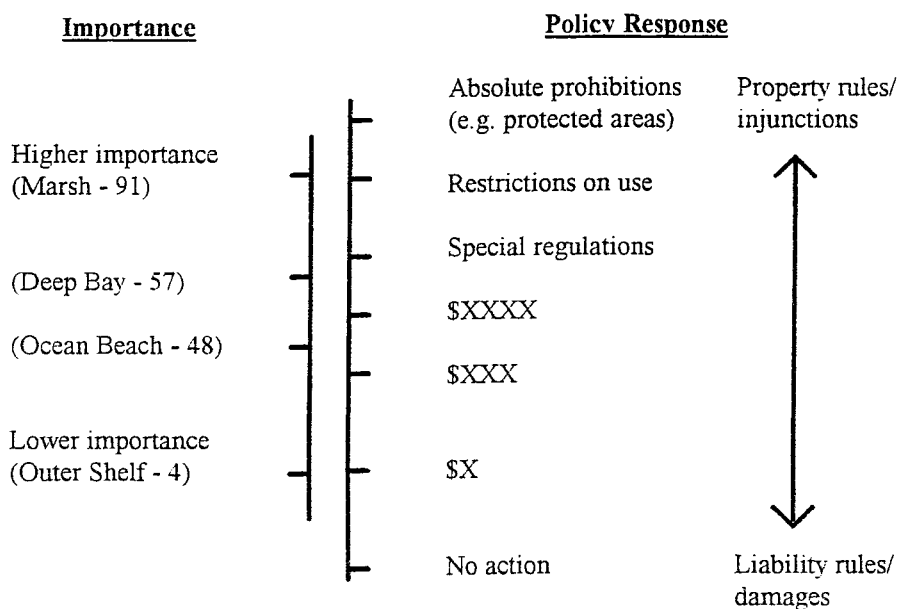
The initial assigned location along the array of possible remedies would necessarily be somewhat arbitrary.[114] While assigning a range of remedies corresponding to the various rankings of the relative importance of losses appears feasible, it seems likely that initial assignments might best be seen as "interim" and subsequently adjusted, with experience, with shifting social values,

---

[114] In Washington State, for example, the legislature arbitrarily imposed a range of $0 to $50 per gallon spilled, which was then applied to an established ranking scheme. *See* Geselbracht & Logan, *supra* note 4.

and with credible new value information. The damage schedule is acknowledged as representing only approximations of cardinal measures of social "worth" of environmental losses, but it does allow policy responses, incentives and compensation remedies to be tied to internally consistent community judgments of the relative costs or importance of various environmental losses.

Figure 1.
Assigning Policy Responses to the Importance Scale

Importance	Policy Response

Absolute prohibitions (e.g. protected areas) — Property rules/ injunctions

Higher importance (Marsh - 91)

Restrictions on use

Special regulations

(Deep Bay - 57)

$XXXX

(Ocean Beach - 48)

$XXX

Lower importance (Outer Shelf - 4)

$X

No action — Liability rules/ damages

It might be desirable to create two kinds of damage schedules, a schedule for consequences (or losses), and a schedule for events (or activities). The consequence damage schedule would be used to assess damage payments for specific losses, measured after the occurrence of a particular event. Its application would require field measurement of the exact losses caused by the event. Examples of losses include area of beach oiled to the extent that it is unusable for recreation, numbers of seals killed, elk killed, old growth Douglas fir trees lost, and kilometres of trout habitat reduced from pristine quality to a specified impaired quality. The total damage payment for an event would be the sum of the damage payments indicated by the schedule for the full set of losses measured for the activity that gave rise to this array of injuries.

In contrast, the event damage schedule would be used to assess damage payments on a more aggregated basis for types of events, such as litres of a certain kind of oil spilled in a certain kind of area at a certain time of year, kilometres of stream affected by a certain kind of stream-flow reduction, or square kilometres of a certain kind of forest burned. The hypothetical damage schedule set out in Figure 1 is a greatly simplified event damage schedule for oil spills. This kind of schedule would be created based on experts' judgments of the most likely consequences (losses) resulting from any of the events. It would be used regardless of the specific consequences that a particular event were to cause. That is, there would be no effort to go out and measure the specific losses following a certain event, but rather the event would be assessed the standard damage payment specified by the schedule for such an occurrence.

Both kinds of damage schedules could be based on public assessments of the relative importance of specific losses, and, if desired, could incorporate perceptions of the relative importance of the causes of loss and the risks involved. The consequence damage schedule would incorporate that information via actual on-site measurement of the consequences, and application of the remedies specified in the damage schedule for those consequences. The event damage schedule would incorporate that information via experts' ex ante judgments of the most likely consequences of particular activities, and public assessment of the relative significance of those consequences. It is obvious, but should be emphasized, that for the damage schedules to be based

50

on public assessments of the relative importance of alternative losses, the alternative losses must be separable (i.e. mutually exclusive). This is required if the policy responses for the different losses are to be added up to arrive at the total response for a given event.[115]

CONCLUSION: THE DAMAGE SCHEDULE AND POLICY OBJECTIVES

In the nineteenth century John Stuart Mill complained of the courts in England: "[T]he procedure of the tribunals is so replete with delay, vexation and expense, that the price at which justice is at last obtained is an evil outweighing a very considerable amount of injustice . . . ."[116] Much the same might easily be said of many modern environmental damage assessments—though it may be less clear that "justice is at last obtained." Assessments of the relative importance of different environmental losses, and their use as an empirical basis for the design of schedules of damages, may offer some advantages in dealing with problems of delay, vexation and expense; and, to the extent that such schedules can convey more reliable information on social preferences than is possible with present, largely ad hoc, valuations, they might do more.

Judgments of the importance of losses and implementation of damage schedule remedies cannot be expected to lead to optimal deterrence and maximum efficiency in the allocation of environmental resources. Not only do they not reflect equity and other social goals of the community, they do not provide benchmarks for optimum tradeoffs. However, the alternative is not an accurate assessment of values, but is instead an absence of credible valuations and a plethora of often self-serving assertions. The major considerations are then, the extent that an

---

[115] In addition to the requirement that the losses be mutually exclusive, it is also necessary that people's judgments of the relative importance of the losses when presented individually be consistent with their judgments of relative importance for the losses when presented as an aggregation—in other words, that their judgments are not subject to the problem of embedding, which has plagued the contingent valuation method (see note 39 and accompanying text).

[116] J.S. MILL, PRINCIPLES OF POLITICAL ECONOMY, BOOKS IV AND V. 243 (Donald Winch ed., Penguin Books 1970) (1848).

importance scale and damage schedule strategy offers advantages over present procedures in dealing with allocation, deterrence and compensation issues involving environmental losses, and whether or not such an exercise is justified.

The approach seems likely to provide incentives, solace to injured parties, and corrective justice consistent with community objectives at lower cost than commonly encountered with present ex-post valuations, but at the expense of other objectives such as less sensitivity to variability among individual cases. Much as with the use of schedules in other areas, such as workers compensation claims reviewed earlier, there is no pretense that the resulting damage awards or the favoring of one resource use over another is based on accurate assessments of monetary values. Just as workers receive compensation that no one suggests is equal to the true monetary value of the harm they suffered and the level of safety investment of employers encouraged by the scheme is unlikely to equate exactly to the added cost and added benefit of reduced injuries, people harmed by environmental losses would receive damage awards that provide solace and recognition that their entitlement is taken seriously, and those considering activities that pose environmental risks would be motivated to take such losses more fully into account in considering the nature and location of such potentially harmful actions. Further, just as workers are assured of receiving larger damage awards for more serious injuries—more, say, for permanent loss of an eye than temporary loss of use of a finger—all parties would be on greater notice that more serious environmental losses would call for greater damage payments and more severe sanction. This is a much more modest objective than promised by complete and accurate valuations. But it is one that appears much more realistic and achievable. The empirical basis is the less demanding judgments of the relative importance of losses, which people are more likely to be able to provide, and a mapping to specific sanctions in the damage schedule, which presumably can be tailored to accommodate community goals, to provide guidance needed to deal effectively and fairly with environmental values.

An importance scale of environmental losses would provide information required to weigh non-pecuniary environmental assets in accordance with aggregate social perceptions of their

importance, at least within a given context and in comparison with other assets included in the same scale, in much the same way as market prices or explicit valuations, when such are available, do. Weightings based on initial judgments would likely be rough approximations. However, more comprehensive scales should evolve with time and experience. To the extent that the importance scales credibly reflect public perceptions, allocation decisions would be more defensible, and conflicts might be reduced. Environmental management, restoration efforts, and industrial development could all be more appropriately targeted with respect to their relative impacts on environmental quality.

There also appear to be several significant cost and procedural advantages offered by the importance scale and damage schedule strategy. Current valuations are almost invariably carried out on a case-by-case after the fact basis. Each is costly, but perhaps more importantly, after the fact loss valuations will almost certainly greatly diminish the desired deterrence effects of whatever sanctions are imposed.[117] Just as producers and consumers cannot rationally respond to price signals if prices are only made known after the relevant decisions have been made, proponents of potentially environmentally harmful developments, shippers of hazardous materials, and dischargers of wastes can hardly be expected to take much, let alone optimum, account of the full costs of their activities if they are only vaguely aware of sanctions that may or may not be imposed on them. A damage schedule could greatly mitigate this problem of post-incident valuation by providing pre-incident damage information.

Not only might assessment costs vary, but transaction costs of imposing sanctions—and thereby having them taken into account—can be expected to be far less with a damage schedule procedure. The nature of the sanction is known in advance, and implementation is then much

---

[117] After the fact *valuation* (discussed here), involving assessment of the *values* of losses, should not be confused with after the fact assessment of the magnitude of biophysical harm, which would still be required with a "consequences" damage schedule (although not required with an "event" damage schedule—see the discussion in Section IVC). Although a "consequences" damage schedule would require after the fact assessment of the nature and magnitude of each of the specific biophysical harms suffered, the remedies (whether damage payments or otherwise) to be assigned to each harm would be specified in advance by the schedule.

more a matter of imposing a posted price to the loss (or to the event, as the case may be) than it is one of producing varied estimates of the value of damages, attempting to discredit opposing methodologies, and delaying procedures.

The deterrence function of damages is compromised to the extent that awards fail to accurately reflect actual costs imposed on injured parties. However, the amount of additional benefit of correctional or mitigation actions that results from added precision in the damage awards is not at all clear in the case of environmental losses. It may well be that responses are quite insensitive to how finely damage assessments are tuned.[118] To the extent that this is the case, then assessments based mainly on relative values, of which much more is known, may provide much of the deterrence and allocative benefit that would be provided by assessments based on absolute values, of which much less can presently be measured.

The importance of the sacrifice of accuracy inherent in pre-incident standardization may be even less for the redress function of damages. As long as the standardized figures fall within general bounds perceived to reflect social values fairly, a damage schedule based on relative values would ensure (especially if posted in advance) that losses considered by the public to be more severe were given more compensation than those that were considered to be less severe. Horizontal equity and fairness are largely prescribed on grounds of equal treatment in equal

---

[118] The usefulness of traditional assertions of optimality conditions and the consequent effectiveness of damages as a deterrent in these cases has been questioned by Castle et al., *supra* note 14, and others. For example, McManus argues that the deterrent effect of damages assessed under environmental legislation in the United States will be undermined by the magnitude of other costs faced by polluters, such as:

> [C]olossal clean-up costs, the costs of EPA's [the United States Environmental Protection Agency's] elaborate oversight and implementation of longer-term remediation, private damage claims, civil and criminal penalties (including, in the case of Section 311 of the Clean Water Act, jail time for a negligent discharge), internal costs and bad publicity. In other words, trustees' claims for injuries to natural resources can be expected to have virtually no deterrent effect.

R.J. McManus, *Why the Ohio Case Shouldn't Matter*, 34 NAT. RES. J. 109, 118 (1994). For a similar argument with respect to personal injury damages, see CANE, *supra* note 20, at 9. The expected response to the imposition of varied sanctions for causing environmental harm is an under-researched and poorly understood relationship. It now appears that many of the substantial investigative resources that have been devoted to environmental valuation efforts might have been more productively employed in exploring this relationship between sanctions and behavior.

circumstances, and the clear embodiment of this principle in a pre-established damage schedule might in itself compensate for some sacrifice of accuracy. For similar reasons, awards based on a damage schedule might provide more appropriate solace, as the degree of comfort provided by an award should be strongly influenced by conceptions of fairness and the expectations created by social norms.

The certainty of assigned damages would also enable actuaries to better estimate the probable costs of environmental losses, making environmental liability insurance more feasible. This, combined with less disputable damage assessments, should result in more successful recovery of environmental losses.[119]

One concern that has been raised about proposals to schedule personal injury damages is that such proposals do not adequately consider the influence of law on social norms. Generally, the argument is that by assigning dollar figures to entities whose values are not properly expressible in monetary terms, damage schedules may erode incommensurability and lead to increased commodification.[120] In contrast, by requiring that non-pecuniary losses be individually assessed, the law demonstrates that each such loss is important to society, perhaps more important than the dollar amount of compensation awarded. This argument has two apparent weaknesses. First, experience with existing personal injury schedules, such as those used in workers' compensation, indicates that valuation processes are complex and are not so easily influenced. Certainly there is no apparent emerging belief that components of the human body are "worth" the amounts specified in workers compensation schedules as compensation for their loss. People seem to be quite capable of maintaining a distinction between the true value of a loss and what society deems to be an appropriate charge or payment for that loss. Second, by placing so

---

[119] Washington State's damage schedule appears to have led to more successful damage recovery (Telephone interview with R. Logan, Washington State Department of Ecology (May 1994)).

[120] See Radin, *supra* note 17, at 83-86; and see the discussion of this issue in Sunstein, *supra* note 48, at 820-824.

55

much emphasis on individual cases, this argument may be an example of, and may itself encourage, what Kahneman and Lovallo call "isolation error"—the cognitive tendency to treat situations as unique.[121] From a wider view, perhaps the normative message conveyed by a legal system that mandates ad hoc assessment of non-pecuniary damages is that process is more important than predictability, consistency or fairness, and that it is appropriate to allocate substantial resources to the large transaction costs of assessing compensation (including, not incidentally, the fees of lawyers and economists) that might otherwise be allocated to compensation itself.

As a final point, although most of the advantages of a damage schedule do not rely on greater precision, in one respect it offers an important advantage over current assessments in its potential for greater accuracy in the assessment of losses. Mapping an empirically based importance scale to a damage schedule may allow for a greater recognition that losses are more accurately reflected by WTA measures rather than by the WTP measures presently used in assessments because of limitations of available measurement techniques. To the extent that changes in economic welfare resulting from an environmental loss, or the perceived reduction of an environmental loss, are more properly assessed by the compensation that injured parties would require to accept the loss (or to forego a reduction in a loss), the ability to more nearly capture this usually much larger value and thereby overcome the serious distortion inherent in current assessments is perhaps one of the most significant advantages.

In summary, a damage schedule would necessarily be somewhat arbitrary, but some degree of arbitrariness might well be outweighed by greater certainty, better enforceability, reduced transaction costs, and a better reflection of community assessments of losses. In addition, and especially given the indeterminacy of the methods currently used to assess non-pecuniary environmental values, a damage schedule based on judgments of relative importance might in

---

121 *See* D. Kahneman and D. Lovallo, *Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking,* 39 MANAGEMENT SCIENCE 17 (1993), discussing the effects of isolation error on choices involving risk.

practice be no more arbitrary than ad hoc measurement, might well be more equitable, and might better express actual social values, as well as being less costly.